 [redacted]

5 FEBRUARY 1963

VOLUME II

OXC-4469

COPY 2 OF 4

(UNCLASSIFIED TITLE)

YJT11D-20A ENGINE FLIGHT SUITABILITY TEST

[redacted]

Approved By [redacted]

Asst. Chief Engineer

[redacted]

FOREWORD

This appendix (A) to report [redacted] describes the results of calibration and inspection of the fuel and control system components for the Flight Suitability Test on YJT11D-20A engine No. FX-116. 25X1

TABLE OF CONTENTS

TABLE OF CONTENTS, CONTINUED

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9
CONFIDENTIAL

25X1

Next 23 Page(s) In Document Exempt

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9

SECTION II

DISCUSSION

A. MAIN FUEL PUMP

1. Introduction

The main fuel pump, manufactured by [redacted] 25X1 200700-10 ([redacted] P/N 2067570, S/N A01A024), had accumulated 132.96 hours total engine time and 64.57 hours total bench time at [redacted] prior to installation on FX-116. Shaft seal P/N 203431 and spline driver P/N 203392 were replaced at 15 hours total engine time and 39 hours total bench time as a result of damage incurred from pump mishandling while installed on another engine. The pumping gears and bearings were replaced at 132.96 hours total engine time and 56 hours total bench time to prepare the pump for this test. The main fuel pump was installed on FX-116 after the sea level engine calibration before the test and after initial engine checks in the endurance facility prior to the test.

The main fuel pump completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 204.20 hours total engine time and 66.07 hours total bench time except for the replaced parts described previously.

2. Description

The main fuel pump consists of a single centrifugal boost-impeller stage and two parallel gear stages. The boost stage supplies fuel to both gear stages, the engine hydraulic system, and the chemical ignition control cooling system. A shear section is provided in the drive for each gear stage to prevent overloading the engine gearbox in event of failure. Check valves are provided at the discharge of each gear stage to prevent reverse flow in case of gear stage failure. Therefore, the loss of one gear stage does not result in engine stoppage. A 40 mesh screen filter is provided between the boost stage and gear stages. This filter is designed to allow fuel to bypass when filter pressure drop exceeds 10 psi. A pressure relief valve is provided at the outlet of the gear stages to eliminate the possibility of damage to the fuel system in the event that abnormal conditions downstream of the pump produce excessive pump discharge pressures. A speed signal is provided to the main fuel control by means of a shaft driven by the impeller gear train. The pump housings are weldments of AM 350 and 355 stainless steel.

3. Analysis

Performance of the main fuel pump was excellent throughout the test. The bench calibrations before and after the test are shown on figure A-2. Tabulated below is the data shown in figure A-2.

Np, rpm	Before Test Flow, lb/hr	After Test Flow, lb/hr	Percentage Difference
500	3186	2890	-9.3
2000	17440	17250	-1.1
3000	26560	26000	-2.1
4000	36690	36250	-1.2
4350	40770	40000	-1.9

The slight change between before and after test flows had no effect on fuel system or engine performance.

Examination of the pump after the test revealed a crack in one of the struts that restrains the interstage filter housing. This strut had been weld repaired previously and the housing had received approximately 47 hours bench and engine run time between the time of the weld repair and installation of the pump on engine FX-116. The point during the test when the new crack developed is unknown. The crack had no effect on pump performance. Corrective action has been initiated to eliminate strut cracking.

Disassembly showed normal wear of parts. The results of the external and disassembly inspection are listed as follows.

Item	Remarks
Main housing	Crack in one of the struts that restrains the interstage filter housing.
Drive end drive gear and bearings.	Normal wear. Uneven tooth contact pattern.
Drive end driven gear and bearings.	Normal wear. Uneven tooth contact pattern.
Anti-drive end drive gear and bearings.	Normal wear. Good tooth contact pattern.
Anti-drive end and impeller drive shafts.	Slight tooth polishing.

Item	Remarks
Impeller drive gear and impeller pinion.	Normal wear.
Shaft seal and spline driver.	Normal wear. Slight scratches on thrust bearing portion of spline driver.

An external view and condition of parts are shown in figures A-3 through A-11.

B. MAIN FUEL CONTROL

1. Introduction

The main fuel control manufactured by [redacted] 588300L76/L80 25X1 ([redacted] P/N 2072042, S/N A06A022) was received from [redacted] and installed on FX-116 without bench test at [redacted] The main fuel control was installed on FX-116 after the sea level engine calibration before the test and after initial engine checks in the endurance facility prior to the tests. The control functioned properly throughout the entire flight suitability test without parts replacement. Engine fuel flow was trimmed as required, using the remote trimmer, to maintain the engine at maximum temperature.

25X1 25X1 25X1

After completion of the endurance test, the engine was mounted in a sea level stand for calibration. During the first calibration run, engine military speed was 210 RPM below limit due to insufficient exhaust nozzle area. Also, the compressor bypass bleed doors did not close as desired. Manual systems were installed to position the exhaust nozzle and the compressor bypass bleed doors. The sea level calibration was then completed without further incident.

FX-116 engine time and the bench calibration after the test resulted in 31.6 hours total bench time and 71.24 hours total engine time at [redacted] 25X1

2. Description

The main fuel control is a hydromechanical device designed to:

1. Schedule fuel flow to the engine burner.

2. Schedule military rotor speed by regulating exhaust nozzle area.

3. Control the position of the engine compressor bypass bleed doors.

4. Provide an arming signal to the afterburner control.

5. Provide pressure signals to the windmill bypass, shutoff, check and dump valve assembly.

The control computes fuel flow ratio using power lever position, engine speed, and compressor inlet temperature as the basic parameters. Fuel flow ratio is defined as fuel flow in pounds per hour divided by burner pressure in psia. This value is represented by the position of a pair of rollers resting on a summation lever contained in the metering valve servo. Engine burner pressure is sensed by an absolute pressure bellows system. The bellows output force is transmitted to the fuel flow ratio rollers producing a torque in the summation lever. This torque must be balanced by a torque proportional to metering valve position. The metering valve servo senses any unbalance of these two torque values and positions the metering valve to re-establish a balanced condition. For example, burner pressure in the engine doubles, but fuel flow ratio remains constant. Therefore, the input torque is doubled and the metering valve must move to a new position to generate an equal but opposite torque. The valve is so constructed as to double its metering area in the new position.

The amount of fuel metered to the engine is directly proportional to metering valve position. This is accomplished by means of a pressure regulating system which acts to maintain a constant pressure differential across the valve. All fuel in excess of that metered to the engine and used to actuate the control servos is returned through a regulating valve to the main fuel pump interstage. The regulating valve is hydraulically positioned by a pilot valve which senses metering valve differential pressure.

Failsafe provisions are incorporated to prevent large changes in metering valve differential pressure in the event of a regulating system malfunction. The regulating system incorporates bimetallic discs to compensate for variations in fuel specific gravity resulting from changes in fuel temperature.

Surge and over-temperature protection for the engine are provided by a three dimensional acceleration cam. This cam limits the maximum fuel flow ratio for any condition of engine speed and compressor inlet temperature. The cam is rotated by a compressor inlet temperature servo and translated by an engine speed servo.

Droop, or speed governing, schedules are computed and transmitted to the fuel flow ratio rollers by the control computing section as a function of engine speed, power lever position and compressor inlet temperature. The minimum fuel flow ratio to prevent engine flame-out is limited by the droop system at a constant value.

The speed servo receives its input signal from a flyweight governor. This signal is amplified by a force balance mechanism to translate the speed-temperature three dimensional cam.

Compressor inlet temperature is sensed by a gas filled bulb that produces a pressure level proportional to temperature. This pressure reacts against a motor diaphragm to produce a force output. This force is amplified through a force-balance servo to rotate the speed-temperature three dimensional cam. The temperature servo also rotates a second three dimensional cam which sets speed references for the area control system.

Compressor inlet pressure is sensed by a bellows arrangement. This signal is amplified through a force balance servo to translate the area control system cam.

Military rotor speed is scheduled as a function of compressor inlet temperature. The desired speed is represented by the area control cam radius. An error signal linkage compares actual rotor speed, sensed by the speed servo, to desired military speed and provides a proportional and integral signal to position a hydraulic transducer valve. The proportional signal gain is established as a function of compressor inlet temperature and pressure by means of a second contour on the area control cam. A hydraulic signal is generated by the transducer valve and fed to the exhaust nozzle control valve. This valve, in turn, positions the nozzle to produce an exhaust area proportional to transmission signal level.

An additional contour cut on the speed-temperature three-dimensional cam provides a signal to position the compressor bypass bleed doors. The signal is amplified hydraulically to produce a high level force output for positioning an external control valve.

A pilot valve in the area control system which senses speed error also supplies a hydraulic pressure signal to the after burner fuel control to prevent afterburning before engine speed reaches ninety percent of military.

A sequencing pilot valve operated by the power lever directs pressure signals to the windmill bypass, shutoff, check and dump valve. This valve assembly responds to the signals to bypass fuel during shutdown, route fuel to the engine during normal operation and dump the fuel remaining in the manifolds after shutdown.

The control also incorporates a limiter to prevent an excessive pressure differential across the engine burner case. This is accomplished by sensing burner pressure through a bellows and relief valve arrangement. If engine burner pressure reaches a predetermined level the limiter will bleed the pressure signal supplied to the control, thus reducing fuel flow to the engine. This will result in a pressure level decrease within the engine burner section.

Main pump discharge fuel entering the control passes through either the 40 micron servo supply filter or the 20 mesh main flow filter. The servo supply filter is continually washed by control inlet flow, thus reducing the possibility of clogging.

Failsafe schedules are included in the speed-temperature cam and the area control cam. In event of a servo malfunction, the schedule, or schedules, affected by that servo will reset to give optimum performance within safe engine operating limits.

The control incorporates a remotely controlled fuel flow trimmer. The trimmer may be used to correct for any small inaccuracies in the control schedule allowing steady state engine operation nearer the maximum temperature limits.

3. Analysis

During the bench calibration after the test, an investigation was conducted to determine the cause for improper exhaust nozzle area and compressor bypass bleed operation. The area system transducer valve was found to be stuck in the full open position. The sticking was caused by an excessive accumulation of electrofilm coating which is applied to the valve as a break-in lubricant. All excessive electrofilm material was removed from the transducer valve and a calibration check was made. Normal operation occurred and excellent correlation with the Hamilton Standard final data was obtained. A change has been issued to discontinue the use of electrofilm on this valve.

The compressor bleed system operated satisfactorily during the bench calibration after the test. It was found that the compressor bleed discrepancy was caused by the external pilot valve which is positioned by the control.

25X1 The [redacted] bench calibration before the test and the [redacted] 25X1
25X1 [redacted] bench calibration after the test results for the important schedules are shown on figures A-12, A-13, A-14, A-15, and A-16.

A minor shift in metering valve differential pressure was discovered to be the cause for small shifts in some fuel flow data points. The problem was traced to a failsafe check valve which did not meet surface finish requirements and was leaking. This check valve prevents large changes in metering valve differential pressure in event of a regulating system malfunction. The check valve was isolated and noted improvement in fuel flow accuracy was obtained. A change is in process to replace the present check valve with a new design that assures more positive sealing.

A partial disassembly showed all parts to be in good condition except the regulating system failsafe check valve and the transducer valve as noted previously. The wear pattern on moving parts varied from slight to moderate. There was no excessive wear.

Main control external views, partial layout, and some component parts are shown on figures A-17 through A-21.

C. MAIN ENGINE FUEL OIL COOLER

1. Introduction

The main engine fuel oil cooler [redacted] P/N 2046443, S/N A23A013) was a new unit prior to delivery to FX-116. The time accumulated on the cooler at the end of the test was 97.35 hours total engine time. 25X1

2. Description

The engine fuel-oil cooler provides cooling for the engine lubricating oil by using engine fuel as the heat absorbing fluid. The cooler incorporates a fuel bypass valve to bypass fuel around the cooler core when the engine fuel flow is greater than the desired core fuel flow. This bypass valve also maintains the pressure drop through the cooler of less than 56 psi.

3. Analysis

Cooler performance was satisfactory during the test.

Disassembly showed that all parts were in excellent condition. External view and parts layout are shown in figures A-22 and A-23.

D. WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE

1. Introduction

The windmill bypass, shutoff, check and dump valve, manufactured by
25X1 [redacted] WBP S/L 576497L7 [redacted] P/N 2050986, 25X1
S/N A46A014), was a new unit that had accumulated 4.91 hours total bench
25X1 time at [redacted] prior to installation on FX-116. This unit completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time and 8.66 hours total bench time.

2. Description

The windmill bypass, shutoff, check and dump valve provides identical shutoff and bypass valves to direct fuel either to the engine burners for normal operation, or to the recirculation circuit during windmill operation in response to signals from the main engine fuel control. During either normal or bypass engine operation, this unit maintains sufficient fuel system pressure to assure normal servo operation in the main engine fuel control and to provide fuel flow for lubricating oil cooling in the main fuel-oil cooler.

A dump valve is provided within this unit to dump fuel from the engine main burner fuel manifold when the engine is shut down.

3. Analysis

Calibrations before and after test agreed favorably and are shown in the following tabulation:

Calibration	Before Test	After Test
Signal Seal Leakage, lb/hr	0.02	2.4
Bypass Min Pressure, psig	112	109
Discharge Min Pressure, psig	112	105
Signal Flow, lb/hr	95	85
Bypass Valve Leakage, cc/min	0.6	1.8
Discharge Valve Leakage, cc/min	0.4	3.2
Overboard Drain Leakage, cc/min	0.8	0.2

Disassembly showed the unit to be in excellent condition. Mating working surfaces of the bypass and discharge valve pistons and sleeves exhibited negligible wear and no detrimental scuffing or abrasion. The surfaces of the check and dump piston and the mating body bore were in excellent condition with negligible wear. Poppet seal surfaces on the pistons and the body bores carried full contact patterns indicating no evidence of surface deformations. Contact edges of all chevron and seal rings were in excellent condition and indicated normal wear.

External views, unit layout, and condition of parts are shown on figures A-24 through A-36.

E. INTERNAL FUEL MANIFOLD ASSEMBLIES

1. Introduction

The internal fuel manifold assemblies [redacted] P/N 2068359 and P/N 2068360, set S/N A17A026) had no engine time prior to installation on FX-116 and completed the entire flight suitability test without parts replacement and without incident. 25X1

The manifolds accumulated a total of 97.35 hours during the test.

2. Description

The internal manifold assembly houses six fuel nozzles arranged in an equally spaced, circular pattern. Each manifold assembly supplies fuel for a single combustion chamber. Eight assemblies are required per engine.

The nozzle is a variable area, dual orifice design with primary and secondary fuel metering orifices. The primary orifice has a fixed area and the secondary metering orifice area varies as a function of manifold pressure. Each nozzle has a wire mesh screen to prevent foreign material plugging the nozzle in the event of a contaminated fuel system.

The nozzle is retained in the manifold with a swirl guide and nut assembly. The swirl guide has air turning vanes to improve atomization of the fuel leaving the nozzle.

3. Analysis

Inspection of the internal manifold assemblies after test showed that minor oxidation had taken place on the swirl guide and nut heatshield. Otherwise, the assembly was in excellent condition.

Calibrations before and after the test are shown on figure A-37. Tabulated below is the average data from the eight manifold assemblies shown on this curve.

Pressure Drop, psi	Before Test Flow, lb/hr	After Test Flow, lb/hr	Difference, %
150	211	220	4.26
200	950	1009	6.22
300	2470	2391	-3.19
500	5193	5066	-2.45

The slight change between before test flows and after test flows had no effect on the fuel system or engine performance.

With the exception of the oxidation of the swirl guide and nut assembly heatshield, no further discrepancies were found on disassembly. Corrective action has been taken to change the material of the heatshield to improve oxidation resistance.

A view of an internal fuel manifold assembly with parts in various stages of disassembly is shown on figure A-38.

F. CHEMICAL IGNITION CONTROL

1. Introduction

The chemical ignition control manufactured by [redacted] 25X1
25X1 574242L12 ([redacted] P/N 2051541, S/N A11A028) was a new unit having accumulated 2 hours total bench time at [redacted] prior to installation on FX-116. 25X1 The control was installed in FX-116 after the sea level engine calibration before the test. The chemical ignition control completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 76.06 hours total engine time and 5.25 hours total bench time.

2. Description

The Chemical Ignition Control ignites either the main burner or the afterburner by injecting a measured amount of triethylborane pyrophoric fluid (TEB) into the appropriate burner automatically when the pressure differential across the fuel nozzles or sprayrings reaches a specified value. Fuel ignition is accomplished by the spontaneous combustion of the pyrophoric fluid in the burner.

TEB sufficient to provide a combined total of twelve lights of either the main burner or afterburner is stored in a self contained tank under inert nitrogen pressure. The nitrogen pressure provides the energy for injection of the TEB into the appropriate burner.

Ignition of the main burner is initiated when the pressure differential across the main fuel nozzles becomes sufficient to actuate the main manifold pressure sensor. Movement of the main manifold pressure sensor opens the main TEB poppet valve thereby lowering the pressure on the underside of the metering piston. Tank pressure on the face of the piston causes it to move, thereby forcing a measured quantity of TEB through the main burner igniter probe and into the main burner.

Metering piston travel completion actuates a reset lever which rotates the linkage assembly forcing the main burner bell crank against the main TEB poppet valve trigger. Trigger rotation allows the spring loaded main TEB poppet valve to return to its closed position. Closing of the main TEB poppet valve results in pressure equalization across the metering piston. The metering piston is returned to its original position by its springs within approximately two seconds and is then ready for another cycle.

Ignition of the main burner cannot be reinitiated until the pressure differential across the main fuel nozzle has been decreased sufficiently to allow the spring loaded main manifold pressure sensor to return to the armed position. This allows the main TEB poppet valve trigger to return to its armed position. Afterburner ignition is accomplished in a similar manner using the afterburner manifold pressure sensor and associated system.

The TEB in the fuel tank may be dumped by the manual operation of an electrical switch. The switch energizes a separate solenoid that applies hydraulic system pressure to the CIS dump actuator piston. Through a suitable linkage system, translation of the dump actuator piston opens the afterburner TEB poppet valve regardless of the afterburner manifold pressure sensor position. The TEB poppet valve opening during dumping is less than during afterburner ignition but it allows the total tank contents to flow past a sealing land through the poppet valve and into the afterburner igniter probe as long as the system receives a dump signal. During normal afterburner ignition, this sealing land blocks the dump flow path from the tank.

A fuel cooling jacket is provided to maintain the temperature of the tank contents at a satisfactory level. Fuel for cooling is supplied from the main fuel pump interstage and returned to main fuel pump inlet. In the event of excessive internal pressures, a safety disc ruptures dumping vaporized TEB and nitrogen into the afterburner through the afterburner igniter probe. There is a filter downstream of the safety disc to prevent fragments of the disc from plugging the afterburner igniter probe.

Provisions are incorporated on the tank for attachment of a ground filling adapter. Through the use of a suitable ground filling system the tank can be refilled. A check valve and a threaded sealing stem are located within the filling connection on the tank to prevent leakage of tank contents. Additional sealing of the tank mounted filling connection is provided by a crush washer seal within the tank connection cover.

3. Analysis

Performance of the CIS unit was excellent throughout the test. Bench calibrations before and after the test were compatible. No internal or external seal leakages were found on the calibrations. Comparisons of the important before and after calibrations are shown on figure A-39.

Disassembly of the CIS unit showed all parts to be in excellent condition. The Teflon seat on the main TEB port valve showed some cold flow, however, the valve functioned normally with zero leakage. The Teflon seat on the afterburner TEB port valve showed normal seat wear with no cold flow. The other Teflon seals in the unit were found to be in satisfactory condition.

All moving parts and piston bores were in excellent condition.

No burned TEB deposits were found at any external points indicating that the high temperature and high pressure crush washer and hi-seals did not leak during the test. No TEB deposits in the linkage housing indicated no leakage of TEB past the Teflon seals on the main poppet stems during the test.

External views, layout of parts and condition of parts are shown in figures A-40 through A-49.

G. CHEMICAL IGNITION SYSTEM INJECTORS

1. Introduction

Clean used main and afterburner injectors were installed at the start of the flight suitability test (Main Burner, [redacted] 25X1
2057522 and BKB 5351; Afterburner, [redacted] 2057523). 25X1
Considerable difficulty was encountered with injector plugging on the afterburner injector and with injector plugging on the main burner injector until a newly developed main burner injector was installed. Three main burner injectors and six afterburner injectors were used during the engine test. A complete history of probe configuration, engine times, and reason for removals is presented in the Analysis section.

2. Description

Both the main burner and afterburner injectors consist of a mounting flange, plumbing threaded connection, and a hollow tube to inject a shot of triethylborane (TEB) measured and supplied from the chemical ignition control, into the desired location of each burner. The main burner injector also contains a separate concentric tube passage and separate plumbing threaded connection to supply burner cooling air pressure to the chemical ignition control so that triggering of a main burner TEB shot will be a function of main burner fuel flow. A similar method of afterburner TEB shot as a function of afterburner fuel flow is utilized but the afterburner duct pressure is supplied to the chemical ignition control from a separate combined static pressure probe.

3. Analysis

a. Main Burner Injector

Main burner injector plugging was a consistent problem throughout the flight suitability test until the BKB 5351 injector was installed. This injector differed from the present bill of material injector 2057522 in that three of the four burner cooling air pressure sense holes are eliminated, an 0.105 inch O.D. hole is incorporated from the injector burner cooling air pressure passage into the TEB passage near the TEB supply connection to provide an air vent into the TEB passage, and the injector is shortened so that projection into the burner can is reduced one-half inch. The BKB 5351 main burner injector configuration was the result of a current injector development program. Engineering change 156029A is in process to incorporate the BKB 5351 main injector configuration into the bill of material as Part No. 2073834. External views of the 2057522 and BKB 5351 main burner injectors are shown on figure A-50.

A history of the main burner injectors used during the flight suitability test is as follows:

Injector P/N	Injector S/N	FX-116 Endurance Time At Installation	Prior* Engine Hours	Injector Engine Hours At Removal	TEB Shots in FX-116	Remarks
2057522	M-14A	0	21.29	35.79	18	Injector plugged at 14.50 endurance hours. Replaced with M-16A.

Injector P/N	Injector S/N	FX-116 Endurance Time At Installation	Prior* Engine Hours	Injector Engine Hours At Removal	TEB Shots in FX-116	Remarks
2057522	M-16A	14.50	0	21.85	6	Injector partially clogged at 36.35 endurance hours. Replaced with M01C.
BKB 5351	M-01C	36.35	0	39.71	8	Injector clean at end of test.

* All injectors clean at installation.

b. Afterburner Injector

Afterburner injector plugging was a problem throughout the flight suitability test. Bill of material injectors 2057523 were used throughout the test; however, six injectors were required. A development program has been in process for some time to solve the afterburner injector plugging problem. A new injector configuration has been developed which appears to correct the afterburner plugging problem, but new injectors with matching plumbing were not available until after the flight suitability test was completed. This new configuration is similar to the main injector vented configuration. A concentric tube passage is provided around the TEB injection tube, a vent supply hole is incorporated in this outer tube and positioned to be near the afterburner outer wall to obtain the coolest vent air, a vent hole is incorporated from the outer vent passage into the TEB passage as close as possible to the TEB supply connection, and the 90 degree elbow at the inlet to the injector is eliminated. Engineering Change No. 156029 is in process to incorporate this new afterburner injector configuration into the bill of material as part no. 2072942. External views of the 2057523 and 2072942 afterburner injectors are shown in figure A-50. Early test afterburner injectors of the new vented configuration showed some physical problems due to thermal differential growth between the inner and outer tubes. Correction for the thermal problem has been tested and Engineering Change No. 156029B is in process to revise the first release. Until revised afterburner injectors are available, the current bill of material injector will require periodic replacement during routine maintenance.

25X1

A history of the afterburner injectors used during the flight suitability test follows:

Injector P/N	Injector S/N	FX116 Endurance Time At Installation	Prior* Engine Hours	Injector Engine Hours At Removal	TEB Shots in FX116	Remarks
2057523	A-10A	0	26.70	34.05	4	Injector partially clogged at 7.35 endurance hours. Replaced with A-03A.
2057523	A-03A	7.35	24.00	31.15	7	Injector partially clogged at 14.50 endurance hours. Replaced with A-12A.
2057523	A-12A	14.50	76.40	83.95	2	Injector partially clogged at 22.05 endurance hours. Replaced with A-18A.
2057523	A-18A	22.05	20.79	35.09	4	Injector partially clogged at 36.35 endurance hours. Replaced with A-02A.
2057523	A-02A	36.35	7.65	22.35	4	Injector partially clogged at 51.05 endurance hours. Replaced with A-08A.
2057523	A-08A	51.05	0	25.01	1	Injector clean at end of test.

*All injectors clean at installation

H. CHEMICAL IGNITION DUMP SOLENOID VALVE

1. Introduction

25X1 25X1 25X1 25X1 25X1

The chemical ignition dump solenoid valve, manufactured by [redacted] S/L 135995 P.L. Rev C [redacted] P/N 2046483, S/N A65A029), had accumulated 1.33 hours total bench time and zero hours total engine time at [redacted] prior to installation on FX-116. This unit completed the entire flight suitability test without parts replacement and without incident. While the solenoid valve was not actuated during the test, it performed satisfactorily at the completion of the sea level engine calibration after the test and at the bench calibration after the test. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time and 3.49 hours total bench time.

2. Description

The chemical ignition system dump solenoid valve provides a hydraulic signal to the dump valve to dump the triethylborane (TEB) from the chemical ignition control. The solenoid valve is electrically energized by a manual switch.

3. Analysis

Calibrations before and after the test agreed favorably and are shown in the following tabulation:

Calibration	Before Test	After Test
External Leakage, lb/hr	0	0
Actuating Current,		
Min Voltage, amperes	0.30	0.35
Max Voltage, amperes	1.15	1.30
Low Pressure Actuating Current		
Min Voltage, amperes	0.30	0.30
Max Voltage, amperes	0.20	1.20
Orifice Pressure Drop, psi	15	17

Disassembly of the solenoid valve showed all parts to be in excellent condition. Mating working surfaces of the solenoid and plunger showed no evidence of wear or binding. The seating surfaces of the solenoid valve, orifice plate, and the poppet valve and body seat were in excellent condition and indicated full contact patterns. The poppet valve O-ring seal was pliable and fully intact.

External views, unit layout, and condition of parts are shown on figures A-51 through A-56.

I. AFTERBURNER TURBOPUMP

1. Introduction

Turbopump A02A020, manufactured by [redacted], 580395L1 25X1
25X1 [redacted] P/N 2067189) was installed on FX-116 at the start of the Flight Suitability Test. This turbopump had accumulated 4.08 hours total bench time, and 90.26 hours total engine time at [redacted] 25X1
prior to installation on FX-116. Total time since complete rebuild using new bearings and seals was 1.00 hour total bench time and 0 hours total engine time. At approximately 37 hours endurance time of the engine, a sharp rise in engine oil consumption from 0.08 gallons per hour to 1.4 gallons per hour was noted. Five (5) hours endurance time later with the shroud open and the engine at idle, an oil leak from the heat-shield of the turbopump was noted. Turbopump A02A020 was replaced by A02A004 (also manufactured by [redacted] 580395L1) at this time. 25X1

FX-116 engine time and the bench calibration and investigation after removal from the engine increased the time on A02A020 to 158.94 hours total engine time and 21.92 hours total bench time except for the new bearings and seals mentioned previously. The results of the bench calibration and investigation after removal from the engine are contained in the analysis section.

The second turbopump, A02A004, was installed on FX-116 at approximately 42 hours endurance time and completed the remainder of the Flight Suitability Test without incident and with engine oil consumption of 0.23 gallons per hour. This turbopump had accumulated 553.83 hours total bench time and 169.52 hours total engine time at [redacted] prior to installa- 25X1
tion on FX-116. Time since installation of new bearings, seals, bearing sleeve, shaft, spring seats, bearing spacer, and lock ring to update the turbopump to 580395L1 was 2.58 hours total bench time and 0 hours total engine time. FX-116 engine time and the bench calibration after the test increased times to 198.19 hours total engine time and 554.49 hours total bench time, except for the new parts mentioned previously.

2. Description

The afterburner fuel pump is a continous duty turbine driven centrifugal fuel pump designed to deliver fuel flows up to 60,000 pounds per hour at pressures up to 1000 PSI. Compressor discharge pressure air is supplied to the turbine through a butterfly valve which is controlled by the afterburner fuel control to drive the pump at the lowest speed which will provide the requested fuel pressure. This minimizes the fuel temperature rise and the amount of compressor bleed airflow required. The airflow metered by the butterfly valve passes into a volute, through the nozzles and an axial flow turbine and is exhausted overboard through a venturi. This venturi creates a vortex during overspeeds imposing back pressures on the turbine providing an effective speed limiting device with no moving parts.

Fuel is supplied to an axial flow inducer which is used as a boost stage and then into a centrifugal impeller which effects the main pressure rise. After leaving the impeller, the flow is collected in a double volute, diffused through a common outlet duct, and then discharged to the afterburner fuel control.

Engine oil is supplied to the turbopump to lubricate the ball bearings at both the pump and turbine ends of the assembly and to provide a continuous oil film between the bearing sleeve and oil housing for damping. Oil is also sprayed onto the rotating seals for cooling. There are double fuel-to-oil and oil-to-air seals having an intervening overboard drain to minimize the possibility of contamination of the engine oil with fuel.

3. Analysis

a. A02A020 Turbopump

This assembly was removed at approximately 42 hours engine endurance time. The bench calibrations before and after the flight suitability test on the turbopump were comparable. Comparisons of pertinent calibration data are as follows:

	Before Test	After Test
Heat shield oil leakage	None	Trace
Maximum vibration	0.20 mils	0.15 mils
Overboard drain fuel leakage	60 cc/35 min	75 cc/38 min
Oil flow	3 lb/min	3 lb/min

Oil leakage was not indicated on the before and after test calibrations because a bench scavenge pump was used on the turbopump oil discharge line which maintained a lower pressure than normal in the seal cavity. The engine uses a gravity feed from the turbopump to the engine oil sump. Special investigation bench tests could not reproduce the oil leakage rate noted on the engine, however, not every engine condition such as vibration and hot ambient could be duplicated on the bench. The special tests duplicated engine conditions as much as possible but could only produce 0.4 gallons of oil leakage in 2 hours compared to approximately 1.4 gallons/hour on the engine.

External inspection and disassembly revealed evidence of oil leakage. There was baked oil on the heat shield; and, the oil housing and turbine housing had to be removed as a unit due to baked oil holding the two housing together. Uneven coke deposits were noted on the oil side of the front carbon seal and its mating ring showed an abnormal sealing pattern due to the seal coke deposits. Drag force at this seal was found to be 6 pounds above the maximum limit of 7 pounds. With this excessive drag, the mating ring would be slow to follow transient axial movement, would allow oil to collect and coke on the sealing surface, and result in oil leakage past the seal. Since the turbine-end oil seal was in excellent condition and showed no evidence of leakage or coking, the oil leakage apparently came from the front oil seal.

Normally any leakage past the front end seal should drain through the overboard drain. However, the overboard drain line from the turbopump was connected from the engine shroud to the vented collecting tank by means of 25 feet of 1/4" o.d. tubing. This long length of small line is believed to have back pressurized this drain system causing the oil leakage from the front seal to be directed to the turbine end of the pump. As evidenced by the air-loaded carbon in the rear seal being stuck to the seal spacer with coked oil and by coked oil deposits in the turbine housing knife edge seals, the oil then leaked by either the turbine housing knife edge seals and heatshield to shrouded area, or the secondary shaft seal to the turbine disc where it exited through the turbine, or the turbine housing bolts and heatshield to the shrouded area. The secondary shaft seal was found attached to the turbine shaft and was not functioning normally.

After the engine test was completed, approximately 50 cc of fluid taken from the turbopump overboard drain line was analyzed and found to be 99% oil and 1% fuel. This substantiates the belief that the overboard drain was not draining freely.

To correct the original source of the oil leak, [redacted] 25X1 has initiated quality control procedures to reject shaft seals with high drag forces. Additional improvements replaced the turbine housing knife edge seals with metal O-seals and eliminate the turbine housing air vent holes. These changes have successfully completed a 50-hour environmental bench test and have been released by [redacted] engineering change 155797 and [redacted] engineering change 73518. Future engine tests will use larger and shorter overboard drain lines. A program is in process to provide pressure balanced shaft seals. These changes should improve the shaft seal leakage problem.

The rear bearing was slightly worn such that the inner race was 0.0005 inches out of flush with the outer race, indicating 0.0003 inches wear. This was not considered abnormal.

The remainder of the turbopump was in good to excellent condition. The front fuel seal and mating ring were in good condition showing no appreciable wear or galling. The rear carbon seal mating ring was in excellent condition, showing a nearly perfect sealing pattern with no buildup of any kind on the carbon. The overboard drain, oil inlet, oil discharge and bearing oil jets were open.

External view, layout of the turbopump, and condition of parts are shown in figures A-57 through A-68.

b. A02A004 Turbopump

This assembly was installed at approximately 42 hours engine endurance time and completed the remainder of the test. The bench calibrations before and after the test were comparable.

	Before Test	After Test
External oil leakage	0	0
Maximum vibration	0.3 mils	0.3 mils
Overboard drain fuel leakage	2 cc/30 min	0
Oil flow	3.5 lb/min	3.5 lb/min

Disassembly showed all parts to be in good to excellent condition. All seal mating rings were of vapor-blasted configuration and had sealing patterns to support the zero leakage noted on the bench calibrations. There was no appreciable backplate, impeller, or inducer rub. The metal O-ring seals in the turbine housing had operated satisfactorily. The area outside the O.D. of the seals was clean, while the area inside the I.D. of the seals was black with coked oil and fuel. The bearings were inspected and all found to be satisfactory, including race flushness.

The rear of the rear oil seal was slightly coked, showing that slight oil leakage during transients was forced by the back pressurized overboard drain line to follow the same leakage path as described for A02A020 through the air-loaded carbon seal and into the turbine cavity. The metal O-ring seals and the slight magnitude of leakage prevented the recurrence of an external leak on the engine.

External view and parts are shown on figures A-69 through A-75.

J. AFTERBURNER FUEL CONTROL

1. Introduction

The afterburner fuel control manufactured by [redacted] 579400L22 [redacted] P/N 2069192 S/N A07A023) had satisfactorily completed a 50-hour simulated mission cycle environmental bench test at [redacted] The control was delivered to [redacted] without disassembly after the [redacted] test, and was installed on the engine after [redacted] bench test. The control completed the entire flight suitability test without parts replacement, without incident, and did not require any adjustments during the test. FX-116 engine time and the bench calibration after the test was 97.35 hours total engine time and 40.97 hours total bench time at [redacted]

2. Description

The afterburner fuel control is a hydromechanical fuel control which schedules metered fuel flow as a function of power lever position, burner pressure (P_b), and compressor inlet temperature (T_{t2}). All schedules are reset as a function of compressor bypass bleed door position. Total afterburner fuel flow which has been metered by the throttle valve is supplied to the afterburner sprayrings.

The total afterburner fuel flow metering throttle valve is positioned by a hydromechanical multiplication of main engine burner pressure biased by compressor bypass bleed position, power lever position, and T_{t2}. The power lever system establishes the position of the rate bar and the P_b system establishes a roller position along the rate bar. The throttle valve is spring loaded against the roller so that throttle valve position is proportional to rate bar angle and roller position. In the minimum flow condition, the throttle valve is fully closed and the minimum fuel flow is established by an adjustable orifice in parallel with the throttle valve. The output of the power lever cam is biased by a 3 dimensional P_b - T_{t2} cam. A pilot valve operated servo system provides force amplification and establishes a rate lever angle proportional to the desired power lever system position.

Burner pressure is measured by an absolute pressure bellows system. The resultant bellows force is utilized within a null balance feedback servo system to establish P_b servo shaft position. The roller position is mechanically established by the P_b servo shaft position. Compressor bypass bleed position is used to mechanically bias the feedback force within the P_b servo system; thereby, biasing throttle valve position through the P_b system.

Compressor inlet temperature is measured by a gas filled bulb at the engine inlet. The resulting gas pressure is amplified by a servo system to rotate a 3 dimensional cam within the P_b servo system.

Throttle valve pressure drop is controlled to a fixed value by a series pressure regulating valve in the main flow path. The differential pressure across the throttle valve is used by the pressure regulator sensor to establish the pressure regulating valve position.

The differential pressure across the peak throttle valve is used by the peak regulator sensor to establish the regulating valve position, metering the desired flow.

The pump controller employs a proportional plus integral servo system to position the butterfly valve in the afterburner fuel pump air supply line to maintain a fixed differential pressure from throttle valve inlet to pressure regulating valve discharge. By controlling this differential pressure to the desired value, sufficient pump pressure is assured without operating at excessive pump speed and fuel discharge pressures. A rupture disc is provided within the pump controller to close the butterfly valve in the event of failures which would cause excessive pressures within the afterburner fuel system.

Initiation of afterburning requires both the proper power lever position and an engine speed of at least 90% of military rated speed. This supplies afterburner fuel pump discharge pressure to the servo side of a switching valve. Under this condition, the switching valve ports afterburner pump discharge pressure to the recirculating valve causing it to close and ports afterburner pump inlet pressure to the shutoff valve allowing it to open for normal afterburner operation. Afterburner shutoff requires that the power lever be in the non-afterburning region regardless of the engine speed level. This supplies afterburner fuel pump inlet pressure to the switching valve servo and reverses the above pressure connections to the recirculating valve and shutoff valve, thereby closing the zone I shutoff valve and opening the recirculation valve. Snap action is achieved in the switching valve through the use of a spring loaded ball carriage and latching detents in the valve bore. During non-afterburning operation the shutoff valve is closed. Minimum fuel flow is returned to the fuel supply through the recirculating valve for cooling purposes. Fuel pressure is supplied to the servo side of the arming signal valve from the main control. This pressure is main fuel pump discharge pressure when the speed is at least 90% of military rated speed and is main fuel pump interstage pressure when engine speed is less than 90% of military. The afterburner control furnishes pressure signals to the afterburner manifold dump valves and exhaust nozzle trim valve to position these valves at afterburning and non-afterburning positions.

A 20 mesh screen is located in the control inlet to filter fuel flow for protection of the unit from foreign matter. Control servo fuel flow passes through a 40 micron screen to protect the servo system. The 40 micron screen is continually washed by control inlet fuel, reducing the possibility of clogging. A relief valve is provided to bypass the 40 micron screen in the event of clogging.

3. Analysis

Bench calibrations before and after the test were compatible and are shown in figures A-76 through A-81.

There was a moderate increase in the fuel flow schedule (0-5%) due to changes in the differential pressure maintained across the throttle valve.

Shutoff valve leakage increased from 12 drops/minute to 19 drops/minute during the test. The power lever shaft secondary seal leakage increased from 0 to 5-10 drops/minute with the overboard drain pressurized to 10 psia; there were no other external leaks observed. The increases in leakage are considered to be of minor importance.

The compressor bleed reset cam actuation force required for movement open to close increased from 19 lb to 50 lb. This force increase did not affect control performance during the engine test. Disassembly of the control showed parts to be generally in good condition; all valves, pistons and linkages showed negligible wear or light polishing.

Items of note from disassembly inspection are as follows:

1. Inlet filter (HSD 579414) clean with the exception of 3 Teflon chips found on the screen.

2. Power lever bearing (HSD 558595), and pump controller bearing (HSD 89016) rough operation due to grit acquired during test.

3. Compressor bleed reset cam (HSD 560154) follower (HSD 560152) housing assembly (HSD 560161); follower found to be scored by bore in housing with spalled cam-follower contact face resulting in high cam actuation forces.

4. T_{T2} cam (HSD 583476) had a light rust formation in the gear portion of the cam.

5. T_{T2} follower assembly (HSD 560030) showed slight wear and rust.

6. All piston rings and piston bores showed light axial scratches.

7. Power lever shaft and pump controller shaft secondary seal "Viton" O-rings (HSD 583462) were deformed to an oval cross section but still flexible and intact.

8. Pump controller rack (HSD 573803) and matching gear (HSD 560003) did not mate properly due to a slight burr or overlap on one face of the gear, causing minor wear on the rack.

9. Pump controller arm (HSD 558993) was severely worn and the pin (AN 960C6L) was worn slightly along their line of contact, but still operating satisfactorily.

10. No contamination was found in the control body or servo passages. Nothing was found during teardown that would interfere with satisfactory operation of the control.

External views, layout of unit, and condition of parts are shown in figures A-82 through A-101.

K. AFTERBURNER MANIFOLD DUMP VALVES

1. Introduction

The afterburner manifold dump valves manufactured by [redacted] 25X1 V-42099-16 and V-42099-17 ([redacted] P/N's 2070043 and 25X1 2070044 S/N's A47A019, A47A020) were new units. The total bench time for each valve was 1.33 hours for S/N A47A019 and 1.25 hours for S/N 25X1 A47A020 at [redacted] prior to installation on FX-116. The valves completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibrations after the test resulted in 97.35 hours total engine time on both units, 5.92 hours total bench time on A47A019, and 2.17 hours total bench time on A47A020.

2. Description

The afterburner manifold dump valves are hydromechanical shear type gate valves with a metal to metal gate seal. The inlet to the valve has a "K" seal flange connection to provide sealing capability during hot shocks. The gate is opened or closed by an actuator rod connected mechanically to the actuator piston and pivoting through a ball joint. The valve housing is sealed from the actuator housing by means of a bellows connected to the actuator rod and valve housing.

The actuator piston is pressure operated by signals from the afterburner control to close and open the gate. The actuator is spring loaded in the open gate direction to provide normal valve open position. The reference pressures used to actuate the valve are afterburner control servo pressure and afterburner control body pressure. In the afterburner control these two pressures are shuttled between two valves which sequence the point of going in or out of afterburning. By using the pressures behind these valves it is possible to shuttle the dump valves simultaneously with the sequencing of the valves in the afterburner control. The valve section of the dump valve is of welded construction and is bolted to the actuator housing. The actuator housing has removable end plumbing fittings and uses "K" type seals between the fittings to actuator housing and the actuator to valve housings.

Two dump valves are used on the engine to dump each of the two manifolds of the afterburner sprayrings. Since the afterburner plumbing system is bifurcated, both manifolds flow simultaneously so that the two dump valves operate simultaneously. The valves are located on the bottom of the engine turbine section and gravity drain the sprayrings and manifolds. The flow capacity of each valve is the equivalent of a 3/8 in. orifice.

3. Analysis

The calibrations before and after the test were compatible and disclosed no leakage at either the gate or at external points. Gate leakage was tested at a differential pressure of 900 psi. A pressure differential of 75 psi across the actuator piston was sufficient to close the valves in all cases.

Disassembly of the valves showed parts to be in good condition. The actuator pistons and bores showed no signs of wear. Seals were undamaged. Gate sealing was satisfactory although there were minor varnish deposits on both gate discs.

External views, unit layouts, and condition of parts are shown in figures A-102 through A-111.

L. HYDRAULIC FLUID FILTER AND BYPASS ASSEMBLIES

1. Introduction

Hydraulic fluid filters A31A036 and A31A037 ([redacted] P/N 2044694) accumulated 0.75 and 1.00 hours total bench time, respectively, prior to installation on FX-116. All parts were new. 25X1

Both filters completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time on both filters and total bench times of 1.83 and 1.91 hours, respectively, on A31A036 and A31A037.

2. Description

Two 25-micron fluid filters, one in the hydraulic system return line and one in the hydraulic pump supply line, prevent contaminant from entering the hydraulic pump inlet. When clean, each filter is capable of handling up to 46 gpm with a pressure drop of less than 10 psi. Should the element become clogged, and the pressure drop across the element exceed 17 psi, a bypass valve in the filter will open, permitting continued operation of the hydraulic system. Each filter element can contain 50 grams of standard contaminant before becoming completely clogged.

3. Analysis

The only contaminant found in either filter after removel from the engine was a minute quantity of sand in the supply filter. Calibrations before and after the test for both bypass valves are shown in figures A-112 through A-114.

Tabulated below are the important calibration points shown on figures A-112 and A-113.

A31A036 - Hydraulic Return Filter

Before Test		After Test	
Flow, lb/hr	P, psid	Flow, lb/hr	P, psid
0	12	0	12
1,000	17	1,000	15.5
16,000	31.5	16,000	28.5

A31A037 - Hydraulic Supply Filter

Before Test		After Test	
Flow, lb/hr	P, psid	Flow, lb/hr	P, psid
0	12	0	12
1,000	16.5	1,000	16
16,000	32	16,000	30

The minor difference in bypass operation before and after the test had no effect on engine operation or performance.

Both filter elements were flow checked after the engine test and were found to be within acceptable values. Calibrations after the test for these elements are shown compared to a new element in figure A-114.

Disassembly showed all parts to be in satisfactory condition. There was no detectable wear on the bypass valve. External views and layout of parts are shown in figures A-115 through A-117.

M. HYDRAULIC PUMP

1. Introduction

The hydraulic pump, manufactured by Vickers, 276463-F ([redacted] 25X1
25X1 [redacted] P/N 2071975, S/N A03A021) had accumulated 0 hours total engine time and 3.99 hours total bench time at [redacted] prior to installation 25X1 on FX-116.

The pump was installed on FX-116 after the sea level engine calibration before the test. The pump completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 76.06 hours total engine time and 6.67 hours total bench time.

2. Description

The hydraulic pump is a fixed angle, variable delivery, 11-piston pump, designed to operate continuously at 5000 pump speed and 3000 psig discharge pressure. The 11 pistons are attached by ball socket piston rods to a flange on the inboard end of the driveshaft. The pistons fit into corresponding bores in a cylinder block, which is rotated with the driveshaft by means of a double universal joint. The universal joint serves to synchronize the motion of the cylinder block with that of the driveshaft.

The cylinder block axis is located at an angle to the axis of the drive-shaft to convert continuous rotary motion of the driveshaft to linear reciprocating motion of the pistons.

The passage of fluid to and from the cylinder bores is afforded by a valve plate, against which the cylinder block bears as it rotates. An inlet slot admits fluid to the retreating pistons during the intake stroke, and an outlet slot ports fluid pumped by the advancing pistons to the pump discharge port. The cylinder block is pressure balanced to maintain uniform contact between the cylinder block and valve plate.

Reduced delivery at constant speed is achieved by the pump control. This control consists of a spool valve, which is acted on by discharge pressure at one end and by a spring at the other end. When discharge pressure becomes high enough to overcome the spring force, the spool valve will move and allow control pressure to be ported into the rotary actuator. The valve plate is attached to this actuator. The plate has an inlet and an outlet port.

When the pump is at full delivery, the inlet port admits fluid to the cylinder during the entire intake stroke, and the outlet port is open to the cylinder during the entire discharge stroke. As the valve plate is rotated through a given angle, a portion of the discharge port is exposed to the inlet cylinders and a portion of the inlet port is exposed to the discharge cylinders. The cylinders within the given angle from both top and bottom dead center are thus shortcircuited to the corresponding intake and discharge ports to reduce flow.

If the valve plate is rotated through 90 degrees from the maximum displacement position, the discharge cylinders are short circuited to the intake cylinders during the entire 180 degrees of the pumping stroke; effective displacement is thereby reduced to zero.

When discharge pressure is reduced to the point where the spring force will move the spool valve back towards its original position, a torsion spring attached to the valve plate returns the valve plate to the full flow position.

3. Analysis

Calibrations before and after the test agreed favorably as shown in figure A-118. There was a very slight seepage of fuel from around the compensator control high pressure cover during the calibration after the test. This leakage did not affect pump performance.

Bench dynamic tests before and after the test revealed the following:

1. Pump sinusoidal-input response showed no significant change in pump natural frequency or gain.

2. Pump step-input response did not significantly change.

3. There was no change in discharge pressure pulsation levels.

Disassembly revealed a normal amount of silver plating erosion between kidney ports on the cylinder block. All bores showed slight signs of cavitation. Slight chipping of the flame plating was evident around the tops of all pistons. All other parts were in excellent condition.

Measurements taken after teardown are as follows:

HYDRAULIC PUMP MEASUREMENTS AFTER TEST

Piston No.	Piston-Bore Clearance, in.	Piston-Rod End Play, in.	Rod-Bearing End Play, in.	Piston-Rod-Bearing Total End Play, in.
1	0.0013	0.005	0.004	0.009
2	0.0012	0.005	0.005	0.010
3	0.0013	0.004	0.004	0.008
4	0.0009	0.004	0.005	0.009
5	0.0011	0.006	0.004	0.010
6	0.0013	0.005	0.005	0.010
7	0.0012	0.005	0.005	0.010
8	0.0012	0.005	0.005	0.010
9	0.0011	0.005	0.004	0.009
10	0.0012	0.005	0.003	0.008
11	0.0015	0.005	0.004	0.009

External view, layout, and condition of parts are shown in figures A-119 through A-122.

N. COMPRESSOR BYPASS BLEED PILOT VALVE

1. Introduction

The compressor bypass bleed pilot valve, manufactured by [redacted] 25X1 25X1 [redacted] (P/N 2059392, S/N A41A034), was a new unit which had accumulated 3.90 hours total bench time prior to installation on FX-116. The valve functioned satisfactorily during the Flight Suitability Test without parts replacement although a large portion of the P&WA heatshield tore and blew off the unit. However, on the initial portion of the sea level engine calibration after the test the unit failed to actuate to the bleeds-closed position and was replaced with a manually operated system for the remainder of the calibration. The Flight Suitability Test schedule resulted in one actuation of the pilot valve per cycle for the first four cycles and then continued bleeds-open position for the remaining three cycles. Therefore, the time of failure is unknown. The loss of a portion of the heatshielding plus nonactuation may have been contributing factors to the failure. FX-116 engine time and bench calibration after the test resulted in 97.35 hours total engine time and 7.34 hours total bench time.

2. Description

The compressor bypass bleed pilot valve is a four-way selector valve which directs hydraulic system pressure to either side of the actuator cylinders that control the compressor bypass bleed doors. This pilot valve is actuated and scheduled by the engine main fuel control through a mechanical linkage.

3. Analysis

The [redacted] heatshielding around the compressor bypass bleed pilot valve was an obsolete design. This heatshielding, which has previously demonstrated inadequate fatigue strength and thermal shielding characteristics, is a single thickness sheet metal design which has been superseded by a double metal skin and insulation blanket type heatshield per [redacted] Engineering Change 152392. The latter configuration improves fatigue strength and thermal shielding properties.

Unshielded exposure of the unit due to loss of a portion of the heatshield during the last test cycles and long test periods sustained without actuation are factors which may have contributed abnormal temperatures and a deterioration of the valve seals. These factors are considered to have contributed to the failure of the valve to actuate to the bleeds-closed position during the sea level engine calibration after the test. When the valve was removed from the engine, and after the valve spool was forced manually to the bleeds-closed position, the spool could be actuated to either position with normal freedom.

Bench calibrations before and after the test agreed favorably and are shown in the following tabulation:

Calibration	Before Test	After Test
External Leakage, drops/min	0	0
Overboard Drain Leakage, drops/min	0	92
Internal Leakage, lb/in	48	50
Actuation Force, lb	15	23

The calibration after the test indicated an increase in overboard drain leakage from zero to 92 drops/minute. This leakage condition is abnormal and considered attributable to the harmful effect on the seals by the abnormally high temperatures sustained by the seals during the unshielded test operation of the valve. The force required to actuate the valve spool after manually freeing the valve was found normal and in agreement with the force before the test.

Disassembly showed all parts to be in excellent condition.

The working surfaces of the valve spool stem and lands and the valve body bore exhibited excellent contact patterns without any evidence of detrimental scoring or abrasion. The seal elements were hardened considerably and a relatively roughened condition of the seal bore surfaces indicated that a substantial loss of the seal binder material had occurred. This seal is a formed composite type of asbestos fiber impregnated with graphite and employing Buna N as a binder. Bench endurance hot-tests of this valve in both shielded and unshielded configurations have shown this seal to be satisfactory in the shielded configuration but marginal in performance in the unshielded configuration. Unshielded operation of the valve during the last cycles of the engine test is considered to have effected a deterioration of the seal elements, which permitted the abnormal overboard leakage measured during the bench calibration after the test. The fuel coking deposits formed in the drain annulus of the seal spacer, attest to the abnormally high temperatures sustained by the seal assembly. At such high temperature conditions the Buna N binder material has exhibited tendencies to bond to the stem surface of the valve spool. This condition is considered to have developed during the last engine test cycles when the valve was operating unshielded for long periods without actuation and rendered the valve inoperative during the initial portion of the sea level engine calibration after the test. At this time, a manual actuation of the valve returned the spool to normal freedom.

A recent Engineering Change, No. 155588, specifies the use of a similar seal employing Butyl as a binder material, this material affords the seal higher temperature capabilities. Incorporation of the later released improved heatshield design will provide further improvement of the seal performance and durability in this valve.

External views, unit layout, and condition of parts are shown in figures A-123 through A-128.

O. START BLEED PILOT VALVE

1. Introduction

The start bleed pilot valve [redacted]P/N 2051927, S/N A45A017) had accumulated zero hours total engine time and 45.34 hours total bench time prior to installation on FX-116. The pilot valve completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time and 0.58 hours total bench time. 25X1

2. Description

The start bleed pilot valve is a servo actuated four-way selector valve which directs hydraulic system pressure to either side of the start bleed actuating cylinders. The servo actuation signal pressure for this unit is the afterburner arming signal pressure as scheduled by the engine main fuel control.

3. Analysis

Calibrations before and after the test were compatible and are tabulated below:

	Prior to Test	After Test
External leakage, lb/hr	0	0
Internal leakage, lb/hr	120	120
Servo signal flow, lb/hr	75	80

Disassembly showed the valve to be in a satisfactory condition except for moderate scuffing of land edges on the pilot valve. External views, unit layout, and condition of parts are shown in figures A-129 through A-133.

P. COMPRESSOR BYPASS BLEED AND START BLEED HYDRAULIC ACTUATORS

1. Introduction

The compressor bypass bleed and start bleed hydraulic actuators,
25X1 manufactured by [redacted] (P/N 2064350, S/N A26A236, A26A237, A26A238, A26A239, A26A240, A26A241, and A26A242), had accumulated zero hours total engine time at P&WA prior to installation on FX-116.

These new actuators were installed on FX-116 after the sea level engine calibration before the test to use actuators incorporating new design high temperature seals. The actuators completed the entire Flight Suitability Test without parts replacement and without incident except for an increase in overboard drain leakage to 4.4 cc/minute. FX-116 test time resulted in 76.06 hours total parts time.

2. Description

Four actuators position the bypass bleed doors and three actuators position the start bleed doors upon signal pressures from their respective pilot valves. The actuators are two-position - open or closed. The actuators in both systems are fuel cooled by a metering orifice in the piston which allows a cooling flow through the piston. When high pressure is applied to either side of the piston, the cooling flow is directed through the piston metering orifice and out the opposite port, where it returns to hydraulic pump inlet.

The high pressure is sealed by the cover on the head end and by five asbestos graphite seals on the rod end. The leakage across the first three seals is routed out the overboard drain. The last two seals prevent external leakage into the engine compartment.

3. Analysis

Calibrations before and after the test are shown in figure A-134.

There was a cooling flow shift due to leakage around the piston. This type of leakage has been found to be due to leakage past the piston rings. Engineering Change No. 156248 is in process to incorporate a revised piston ring having a step joint sealing ring and an expander ring.

The increased overboard drain leakage of 4.4 cc/minute noted during the engine test is slightly above the 3.5 cc/minute limit that is acceptable for new parts.

Disassembly showed all parts to be in good condition. External views of parts layout are shown in figures A-135 and A-136.

Q. EXHAUST NOZZLE CONTROL

1. Introduction

The exhaust nozzle control manufactured by [redacted] 25X1
25X1 581777L5 [redacted] P/N 2068802 S/N A08A028) was a new

unit having accumulated 1.83 hours total bench time at [redacted] prior to installation on FX-116. This unit completed the entire flight suitability test without parts replacement and without incident. A problem of insufficient exhaust nozzle area during the sea level engine calibration after the test was due to a stuck transducer valve in the main fuel control. FX-116 engine time and bench calibration after the test resulted in 97.35 hours total engine time and 4.08 hours total bench time. 25X1

2. Description

The Exhaust Nozzle Control (ENC) directs high pressure fuel from the hydraulic pump to the exhaust nozzle actuators to position the nozzle area to a value scheduled by the Main Fuel Control in order to maintain desired engine speed. The desired nozzle area is computed in the Main Fuel Control and transmitted, as a pressure signal, to the Exhaust Nozzle Control through a hydraulic transmission line. The desired nozzle area is compared to the actual area, as sensed by the actuator feedback position and the ENC positions a pilot valve to direct high pressure fuel to the four (4) actuators to position the exhaust nozzle at the desired area.

The signal to the ENC (transmission pressure) acts on a differential area plunger, and through a tension spring applies a force to a moment summation bar. Other moments, proportional to actuator position and to pilot valve position, are also applied to the moment summation bar through appropriate springs. The error between the desired and actual areas is amplified through a flapper servo and establishes a pilot valve position proportional to the error signal. A proximity damper is also attached to the moment summation bar to prevent undesirable resonant conditions.

To insure a stable servo supply pressure to the ENC, a Pressure Regulating Valve is provided which supplies 1000 psi above the A/B Pump Inlet pressure. A Pressure Drop Controller maintains the ENC body drain pressure at a specified level above the drain sink.

3. Analysis

Bench calibrations before and after the test were compatible and the results are shown in figures A-137 through A-139.

ENC dynamic response is the best measure of overall control performance and its effect on engine stability. There was a minus two (2) degree phase lag shift at 4 cps and a plus four (4) degree shift at 3 cps on the calibration after the test with respect to the calibration before the test. This minor shift would have no effect on engine or control system operation and is within the repeatability limits of the bench.

There was approximately 75 lb/hr decrease in transmission fuel flow with input signal in the 420 psi differential pressure range. This magnitude of fuel flow change does not affect unit performance and is outside the tolerance band of the test stand. This shift is most probably a combination of parts wear and slight temperature relief of the rates of the springs. A check of the spring rates of all springs within the valve showed all to be within drawing limits. This type of shift within drawing limit tolerances has been experienced before and is not considered unusual or detrimental to ENC performance.

Disassembly showed the "Fiberfrax" insulation used to insulate the ENC and reduce fuel temperature rise within the valve was cracked, separated, and in one spot completely missing. [redacted] Engineering Change No. 154646 eliminates this "Fiberfrax" insulation and replaces it with an insulation blanket of "Min-K" sandwiched between stainless foil. 25X1

There was a carbon and fuel varnish build-up on the ENC Pilot Valve adjacent to the seal ring. This varnish did increase the friction between the valve and bore but did not affect unit performance. This problem is currently under investigation.

There were wear marks on the drain edge of the pilot valve close land. These marks are caused by the high velocity fuel flow and are not considered detrimental to unit performance. Small surface cracks were found on the ENC feedback shaft in the area of the back-up chevron seal. While these cracks have no adverse effects they are currently under investigation.

External views, unit layout, and condition of parts are shown in figures A-140 through A-147.

R. PRESSURE REGULATING VALVE

1. Introduction

The pressure regulating valve manufactured by [redacted] 25X1
25X1 580888L2 [redacted] P/N 2067253 S/N A44A028) was a new unit having accumulated 11.18 hours total bench time at [redacted] prior to 25X1
installation on FX-116. This unit completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time and 14.68 hours total bench time.

2. Description

The pressure regulating valve supplies 1000 psi servo fuel pressure for Exhaust Nozzle Control operation by metering fuel flow from the 3000 psi Hydraulic Pump discharge pressure. Regulation is accomplished by balancing the force produced by regulated pressure on one end of the valve against a spring force on the other end of the valve.

Afterburner pump inlet fuel pressure is used for a reference pressure and leakage flow sink. The regulator is designed to provide a minimum reduction of inlet pressure oscillations of 20:1 at a frequency of 5 cycles per second. This provides isolation of the nozzle control system from hydraulic pressure oscillations.

3. Analysis

The calibrations before and after the test were compatible and are shown in figure A-148. A 2% shift is evident between these bench calibrations. This minor shift was not detrimental to system performance.

Disassembly showed all parts in good condition. However, there was distortion on two of the three standpipe sealing surfaces due to excess torque at assembly. A small steel shaving was found on top of the spring retainer, but there was no evidence of this shaving having come from the PRV. It did not affect unit performance.

External views, unit layout, and condition of parts are shown in figures A-149 through A-153.

S. PRESSURE DROP CONTROL

1. Introduction

The pressure drop control manufactured by [redacted] 25X1
25X1 580710L1, ([redacted] P/N 2063439 S/N A37A011) was a new unit having accumulated 1.42 hours total bench time at [redacted] prior to 25X1
installation on FX-116. This unit completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time and 2.00 hours total bench time.

2. Description

The exhaust nozzle control (ENC) utilizes a regulated supply pressure for the nozzle actuator pilot valve and the area servo pilot valve. The ENC also requires that this pressure be referenced to a controlled, low pressure sink. Further, to stabilize the ENC system when pressure fluctuations enter through the drain system and impose erroneous signals on the ENC servo pilot valve, a valve is required to provide a time delay in this error signal equivalent to that of a fixed orifice. The pressure drop controller (PDC) provides this time delay function and also maintains the ENC body pressure at 50 psi above the drain sink. This valve also incorporates a pressure relief valve for the ENC body in the event of an ENC seal failure. This feature insures that the ENC casting will not be overpressurized by the 3000 psi source.

3. Analysis

Bench calibrations of this unit before and after the test compare as follows:

	Fuel Flow, lb/hr	Pressure Drop, psi
Before Test (18 Oct. 62)	100	51
After Test (16 Jan. 63)	107	49

The above data indicates no significant shift in calibration.

Minor exterior rust and a distorted sealing surface on a fitting were noted on the unit after the test. Previous experience with this type distortion indicates it is caused by overtorquing. This fitting did not leak during engine test or during the calibration after the test.

Disassembly showed all parts in good condition; however, minor rust spots were evident on the valve housing. These spots are not considered significant. No wear marks or abrasive spots were evident in either the bore or piston.

External views, unit layout, and condition of parts are shown in figures A-154 through A-157.

T. EXHAUST NOZZLE TRIM VALVE

1. Introduction

The Exhaust Nozzle Trim Valve ([redacted] P/N 2067072 25X1
S/N A36A013) had accumulated 0 hours total engine time and 3.5 hours total bench time prior to installation on FX-116. The Exhaust Nozzle Trim Valve completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time and the bench calibration after the test resulted in 97.35 hours total engine time and 4.5 hours total bench time.

2. Description

The Exhaust Nozzle Trim Valve (ENTV) reduces the exhaust nozzle area at speeds below military set speed in order to reduce the thrust discontinuity produced by the large exhaust nozzle area transient otherwise required to initiate speed control by the exhaust nozzle. At higher power settings, up to military power, the main engine control imposes additional exhaust nozzle area reduction to hold engine speed constant.

When initiating and during afterburning, the A/B control servo pressure drives and maintains the ENTV to the "off" position and maximum exhaust nozzle area can be obtained to allow adequate exhaust area for speed control up to maximum afterburning.

3. Analysis

Calibrations before and after the test compare as follows:

	Transmission Flow, lb/hr	Pressure Drop, psi
Before Test (19 Oct. 1962)	270	610
After Test (16 Jan. 1963)	265	600

The less than 2% flow change is insignificant to engine operation.

Disassembly showed the parts to be in good condition. No scoring or marking of the piston or bore was evident. External views, unit layout, and condition of parts are shown in figures A-158 through A-161.

U. EXHAUST NOZZLE HYDRAULIC ACTUATORS

1. Introduction

The exhaust nozzle hydraulic actuators manufactured by [redacted] 25X1
25X1 [redacted] (P/N 2072164, S/N A27A096, A27A098, A27A099, and A27A100), had zero engine time at [redacted] prior to installation on FX-116. 25X1

The actuators completed the entire flight suitability test without parts replacement and without incident. FX-116 engine time resulted in 97.35 hours total parts time.

2. Description

The exhaust nozzle actuators modulate the afterburner jet nozzle exit area upon response of signal pressures governed by the exhaust nozzle control. The actuator consists of a fuel cooled piston, a cover assembly with cooling tube, a piston liner, an internal seal, piston shaft seal, and actuator housing. The piston shaft is cooled by routing a portion of the signal flow through a series of orifices located in the piston head, piston liner, and cover cooling tube. The cooling flow is then returned through a return line to the hydraulic pump inlet. The orifice in the cover cooling tube is sized to prevent excessive cooling flow should the internal seal fail.

The high pressure is sealed by the cover on the head end and by two sets of asbestos graphite seals on the rod end. Any leakage across the first set of rod end seals is routed out the overboard drain manifold. The second set of rod end seals prevents external leakage.

3. Analysis

Calibrations before and after the test were compatible and are shown in figure A-162. Overboard drain leakage increased from zero cc/hr before the test to 3.5 cc/min after the test. This increase is considered undesirable although it does not affect actuator performance. Extensive testing is in process on new seal materials to reduce the overboard drain leakage.

Disassembly showed some deformation of the teflon internal seals in all actuators. This seal deformation did not affect performance. An improved seal material of [redacted] SP plastic has successfully completed testing and is being incorporated in the Bill of Material by Engineering Change No. 156230.

The rear mount lugs on the housing were bent slightly but did not affect actuator operation. This bending is caused by the mounting bracket interference due to differential expansion during engine operation. This condition is being corrected by a revision to the mounting lug brackets. This revision provides increased clearance and is being incorporated in the Bill of Material by Engineering Change No. 155843.

All other parts were found in excellent condition.

Actuator layout, and condition of parts are shown in figures A-163 through A-167.

V. HARNESSES

1. Electrical Harness

a. Introduction

The harness manufactured by [redacted] (3 piece) 10-321500-1X6

10-321501-1X3, 10-321512-1X1 [redacted] P/N 2067517, 2067518, 2067519), was a new part prior to the engine test. Checks for continuity and insulation resistance were made prior to the test. 25X1

The electrical harness was installed on FX-116 after the sea level engine calibration before the test. The electrical harness completed the entire flight suitability test without parts replacement. The oil low level sensor warning indicator could not be de-energized during the test due to the test stand cable having insufficient capacitance shielding.

The starter bleed door position indicator system operated inconsistently throughout the test due to problems in the test stand electrical system.

At the beginning of the sea level engine calibration after the test the tach generator would not read because of a broken connector. A jumper lead was used to bypass this connector on the harness.

FX-116 engine time resulted in 76.06 hours total engine time on the electrical harness.

b. Description

The electrical harness is composed of 3 parts, an AC harness, DC harness and a junction box. The AC harness, P/N 2067517, provides electrical service to the tach generator, fuel control remote trimmer, and oil pressure transmitter. The DC harness, P/N 2067518, provides electrical service to the oil level low sensor, start bleed door position indicator and the CIS dump solenoid. The AC and DC harnesses are connected to a junction box which integrates all wiring to one connector at the front of the engine.

The harnesses are of flexible construction with an Inconel outside braid. The basic wire is Ni-Clad copper with quartz and mica glass tape insulation.

c. Analysis

Disassembly showed a broken connector on the tach generator lead. The broken connector allowed one of the two leads in the connector to short to ground. A change in the construction of the shell of the connector is in process to correct this problem. This change will prevent rotation of the assembly nut on the connector.

All connectors were easily removed from the components. Insulation resistance measurements, after the test, showed that the DC cable P/N 2067518 had numerous leads with low insulation resistance. However, no detrimental effects because of this were noted at test. The DC cable was returned to the vendor for study of possible corrective procedures.

Insulation resistance measurements after the engine test on the AC cable P/N 2067517 and on the J-box 2067519 were acceptable. An external view of the harness is shown in figure A-168.

2. Thermocouple Harness

a. Introduction

This harness, manufactured by [redacted]-11036, S/N 2 (T_{T5} Averaging, Ground Checkout, and Oil Thermocouple Harness [redacted] P/N 2072442), was a new part prior to the engine test. Checks for continuity and insulation resistance were made prior to the test. The harness was installed on FX-116 after the sea level engine calibration before the test. The harness completed the entire flight suitability test without incident except for an open circuit in one individual thermocouple lead. 25X1 25X1

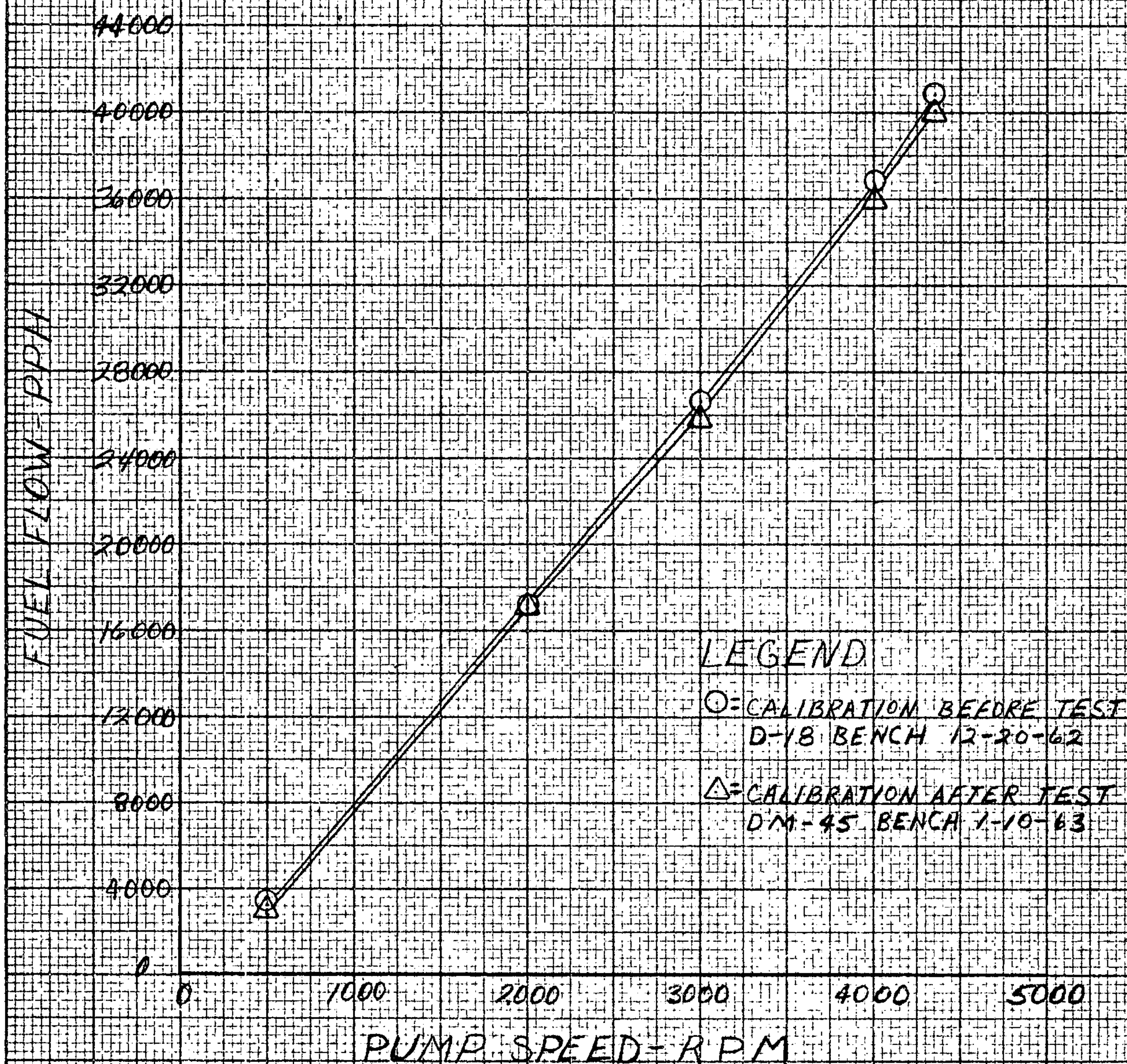
b. Description

The T_{T5} thermocouple harness is of flexible construction and averages the output voltage of five T_{T5} thermocouples using an equal lead length compensated ladder circuit and provides for ground checkout of each thermocouple. The harness connects to two elements of each probe. One element of the probe is connected to the averaging circuit and the other element is routed to the junction box and to a ground checkout connector. Provision is made in the junction box for replacing any thermocouple in the averaging circuit with a thermocouple from the individual circuit.

c. Analysis

Electrical checks after the test showed that all circuits were continuous. No reason was found for the open circuit of one individual thermocouple lead during the test. Electrical checks before and after the test were compatible. The connectors, terminals and outer braid were in good condition. External view of the harness is shown on photograph FE 30970, (figure A-168).

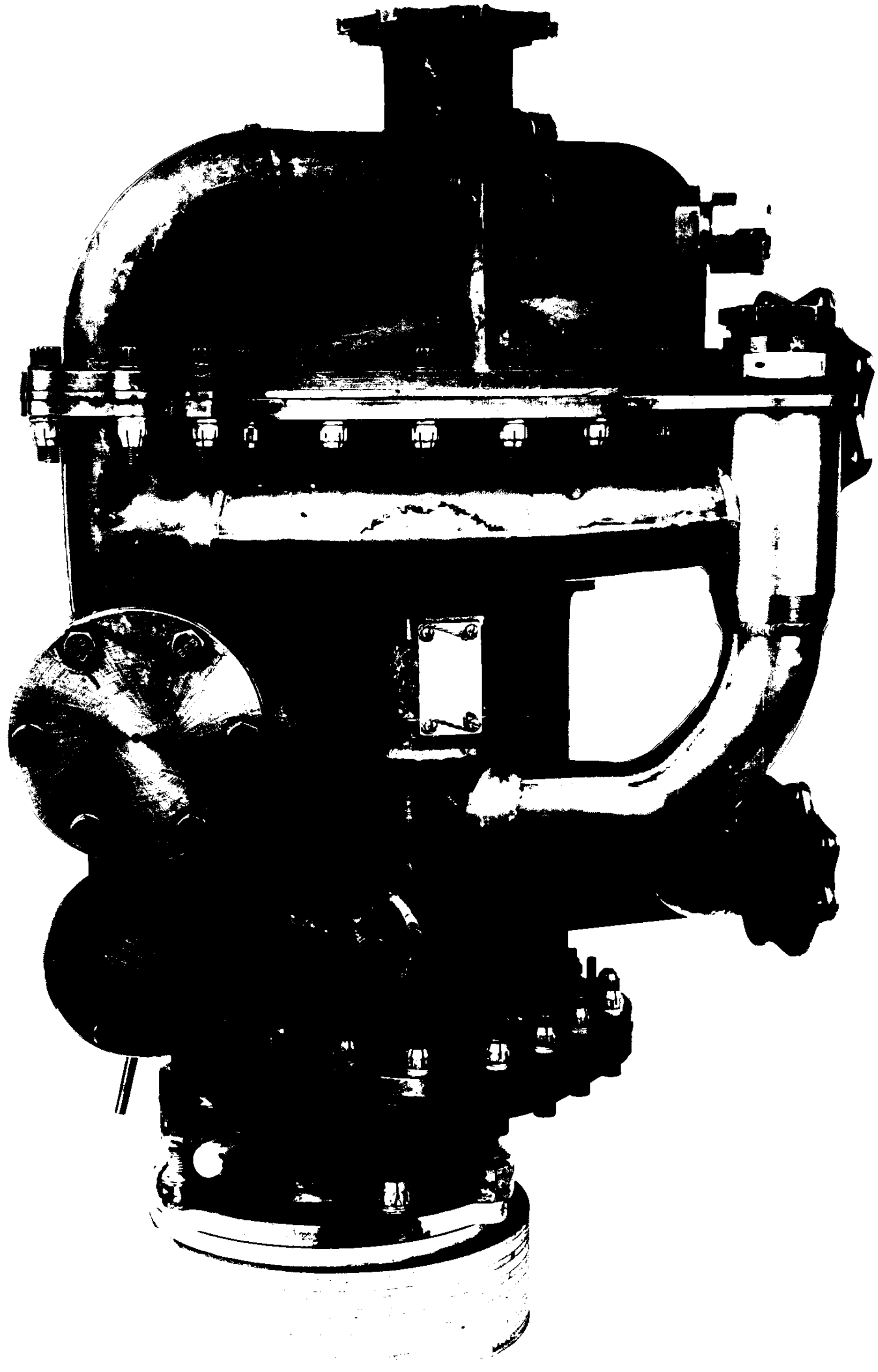
MAIN FUEL PUMP CALIBRATION



T.R.W. 200700-10 P+WA P/N 2067570 S/N A01A024 CALIBRATIONS FOR YJT11D-20 FLIGHT SUITABILITY TEST

ENG./RIG NO. FX-116	DATE 1-20-63
TYPE YJT11D-20A	DRAWN BY J.W.C.
STAND NO. C-4	CURVE NO. DF 21267
TEST DATE 12-28-62 TO 1-4-63	

FIGURE A-2



25X1

FIGURE A-3

25X1
25X1

[redacted]

[redacted] 200700-10 MAIN FUEL PUMP, [redacted]
P/N 2067570 S/N A01A024, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 66.07 HOURS TOTAL BENCH TIME. 204.20 HOURS TOTAL ENGINE TIME.

1/11/63 FX-116 FE 30441

25X1

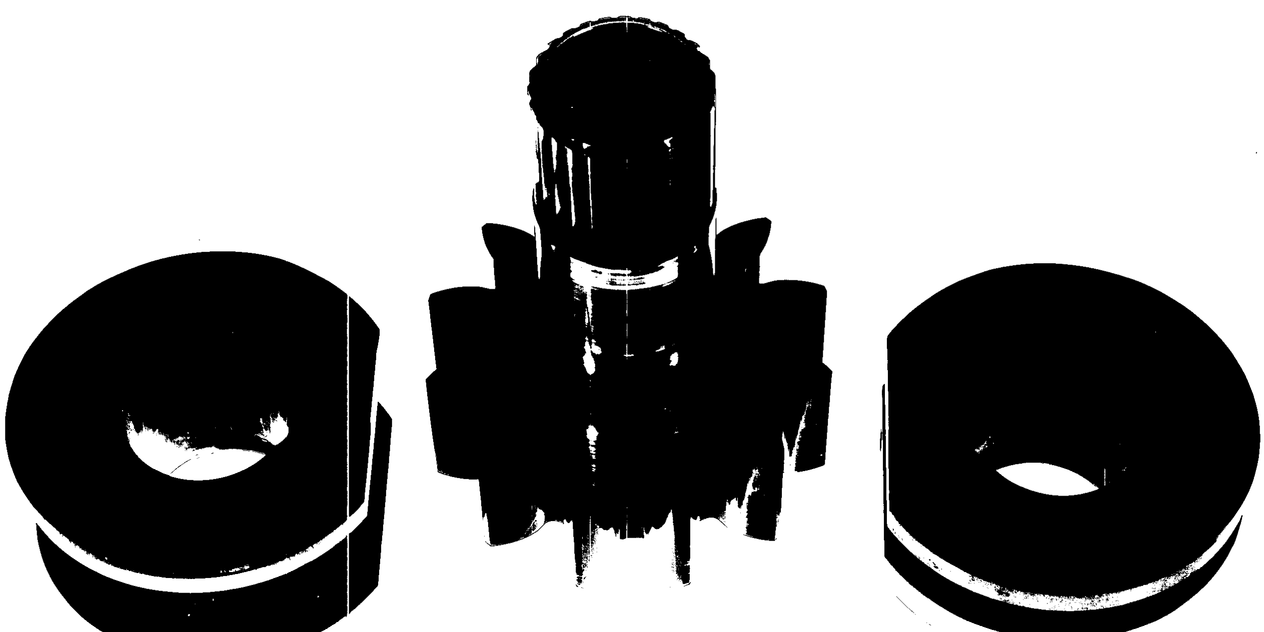
FIGURE A-4 APPROXIMATELY 3X MAGNIFICATION

25X1

25X1

[redacted] 200700-10 MAIN FUEL PUMP, [redacted] P/N 2067570 S/N A01A024, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING ONE OF THE STRUTS WHICH RESTRAIN THE INTERSTAGE FILTER HOUSING. 66.07 HOURS TOTAL BENCH TIME, 204.20 HOURS TOTAL ENGINE TIME.

1/11/63 FX-116 FE 30447



25X1
25X1

[redacted]

FIGURE A-5

[redacted] 200700-10 MAIN FUEL PUMP, [redacted] 25X1
P/N 2067570 S/N A01A024, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING DRIVE END DRIVE GEAR AND BEARINGS. 10.00 HOURS TOTAL BENCH TIME, 71.24 HOURS TOTAL ENGINE TIME.

1-30-63 FX-116 FE 30613

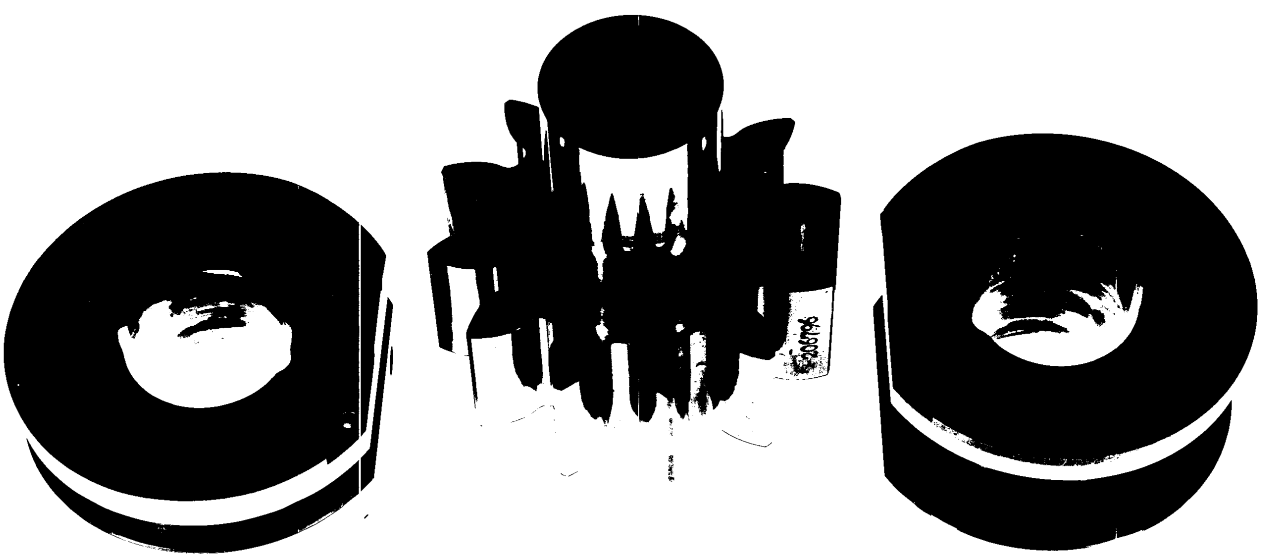
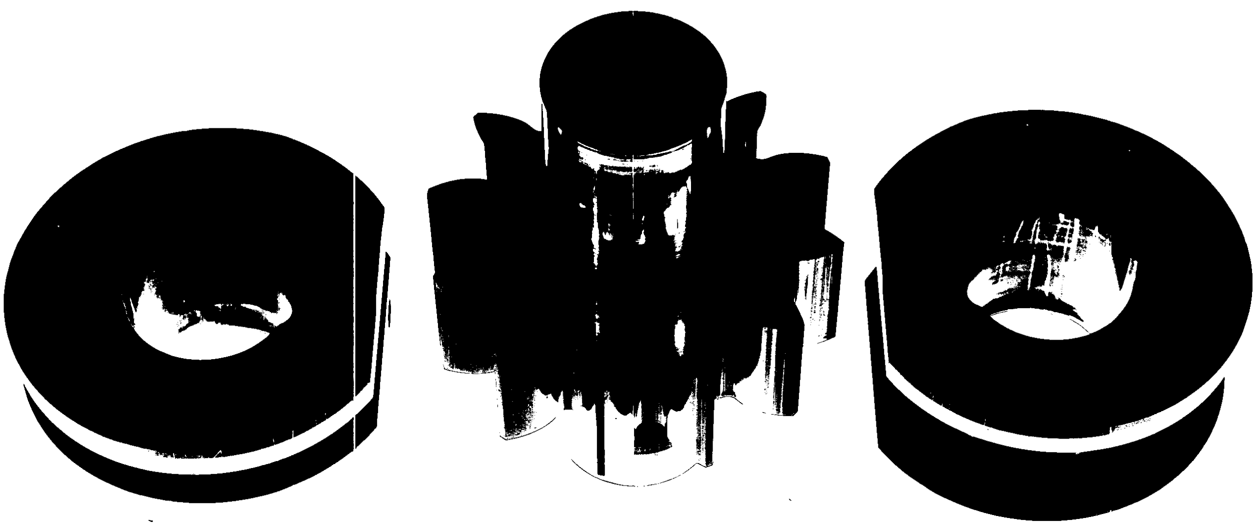


FIGURE A-6

25X1
25X1

[redacted] 200700-10 MAIN FUEL PUMP, [redacted] P/N 2067570 S/N A01A024, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING DRIVE END DRIVEN GEAR AND BEARINGS. 10.00 HOURS TOTAL BENCH TIME, 71.24 HOURS TOTAL ENGINE TIME.

1/16/63 FX-116 FE 30614



25X1
25X1
25X1

[redacted]

FIGURE A-7

[redacted] 200700-10 MAIN FUEL PUMP,
[redacted] 2067570 S/N A01A024, AFTER FLIGHT SUITABILITY TEST
ON YJT11D-20A ENGINE FX-116 SHOWING ANTI-DRIVE END
DRIVE GEAR AND BEARINGS. 10.00 HOURS TOTAL BENCH TIME.
71.24 HOURS TOTAL ENGINE TIME.

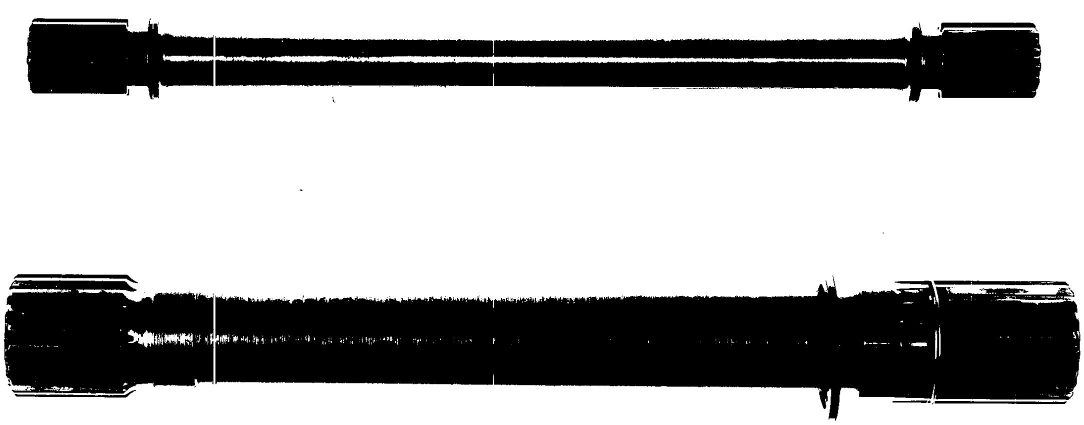
1/16/63 Fx-116 FE 30615

25X1
25X1
25X1

FIGURE A-8

[redacted] 200700-10 MAIN FUEL PUMP, [redacted] P/N 2067570 S/N A01A024, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING ANTI-DRIVE END DRIVEN GEAR AND BEARINGS. 10.00 HOURS TOTAL BENCH TIME, 71.24 HOURS TOTAL ENGINE TIME.

1/16/63 FX-116 FE 30616



25X1

25X1

[redacted]

FIGURE A-9

[redacted] 20070C-10 MAIN FUEL PUMP, [redacted] P/N 2067570 S/N A01A024, AFTER FLIGHT STABILITY TEST ON YJT11D-20A ENGINE FX-116, SHOWING DRIVE END AND IMPELLER DRIVE SHAFTS. 10.00 HOURS TOTAL BENCH TIME. 71.24 HOURS TOTAL ENGINE TIME.

25X1

1-30-63 FX-116 FE30617

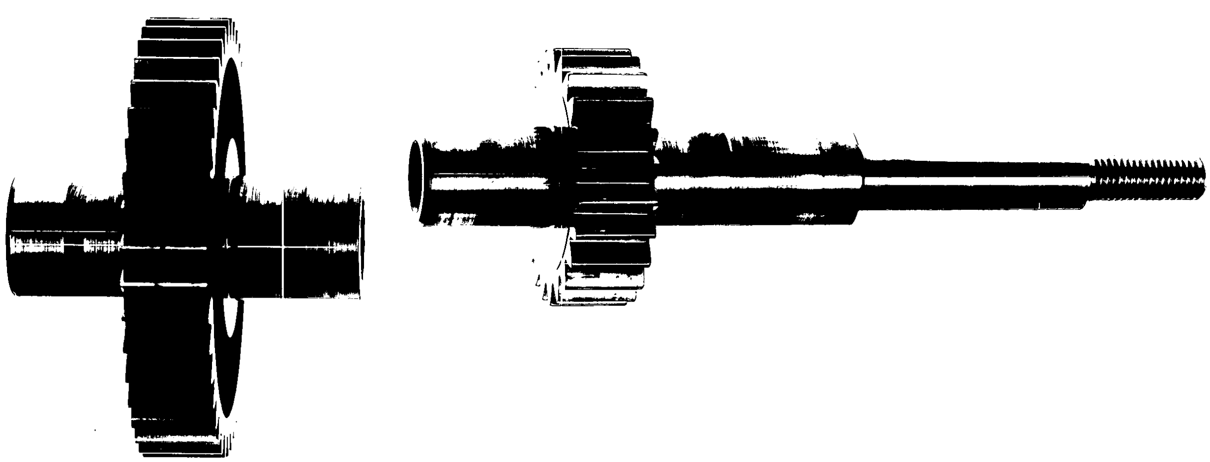


FIGURE A-10

25X1
25X1
25X1

[redacted]

[redacted] 200700-10 MAIN FUEL PUMP, [redacted] P/N 2067570 S/N A0TA024, AFTER FLIGHT SUIT-ABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING IMPELLER DRIVE GEAR AND PINION. 66.07 HOURS TOTAL BENCH TIME. 204.20 HOURS TOTAL ENGINE TIME.

1/16/63 FX-116 FE 30618

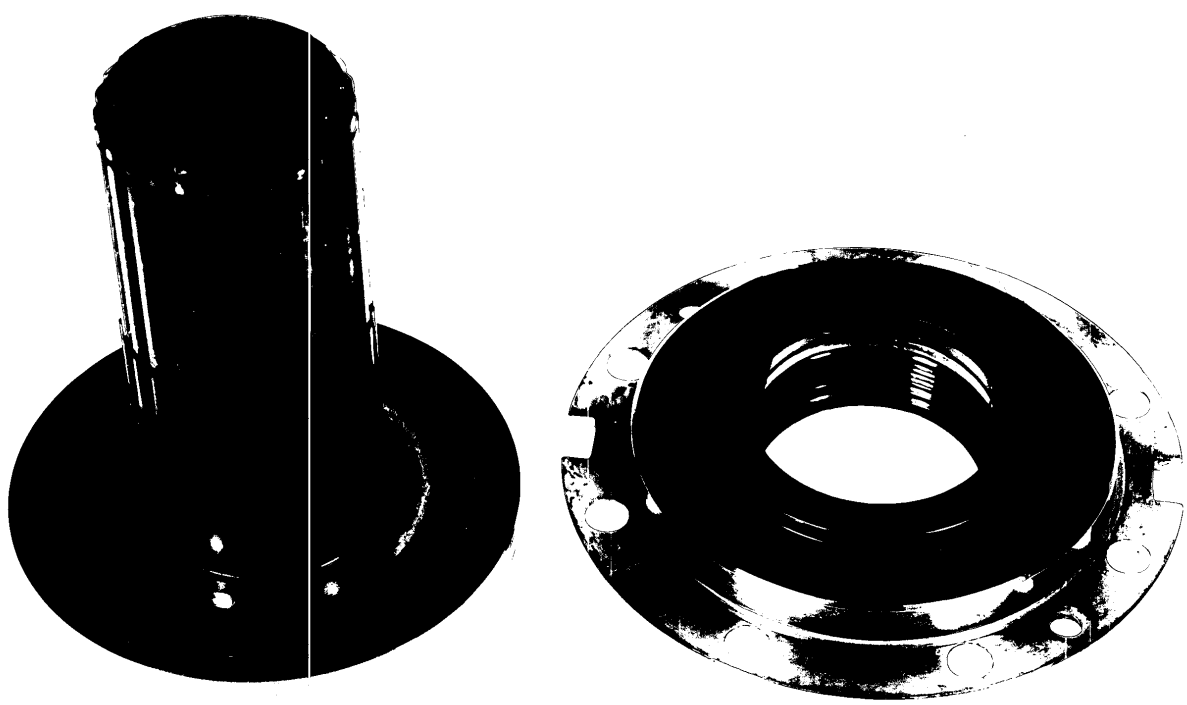
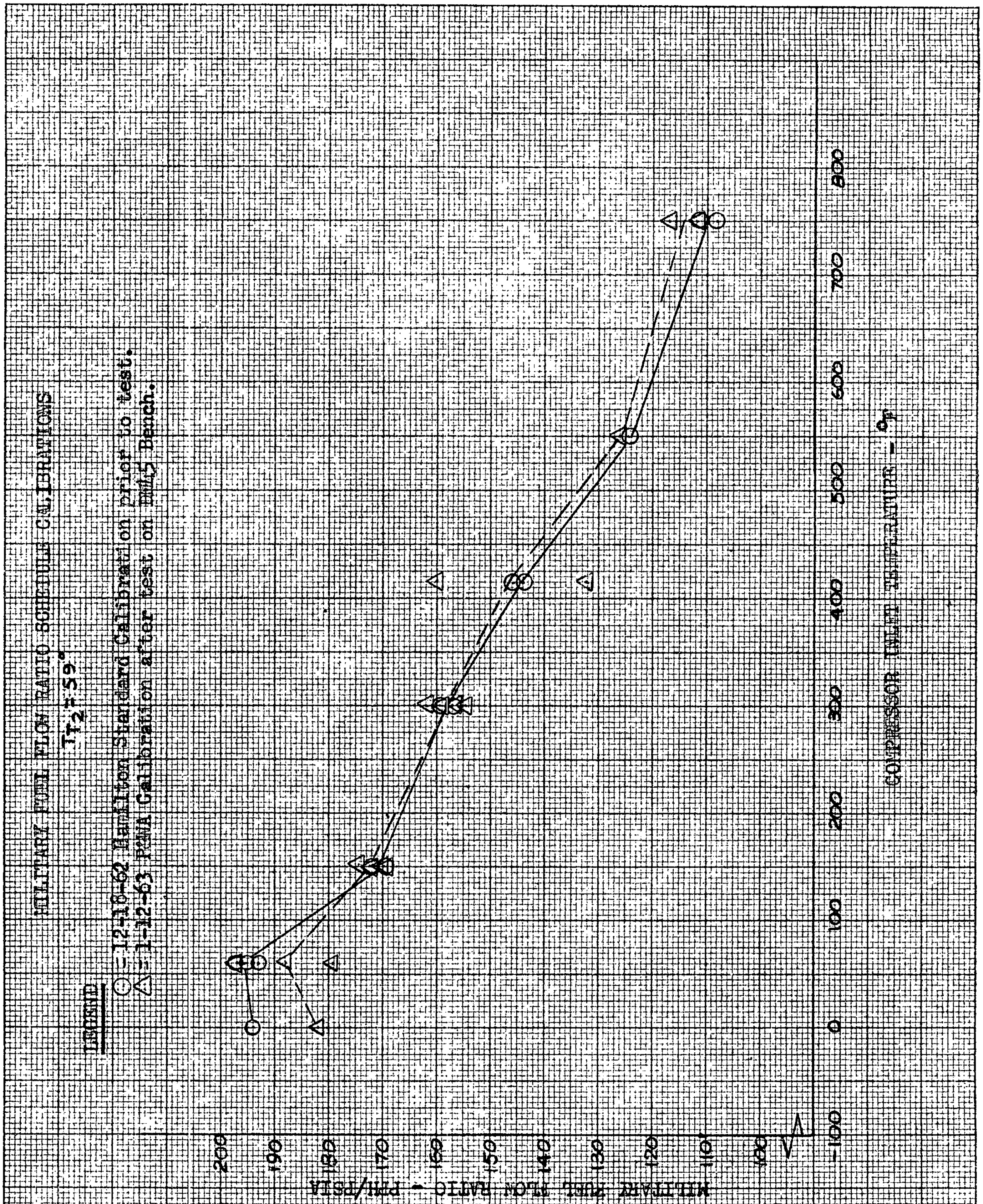


FIGURE A-11

25X1 [redacted] [redacted] 200700-10 MAIN FUEL PUMP, [redacted] 25X1
P/N 2067570, S/N A01A024, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. SHOWING SHAFT SEAL AND SPLINE DRIVER. 27 HOURS TOTAL BENCH TIME. 89.03 HOURS TOTAL ENGINE TIME.

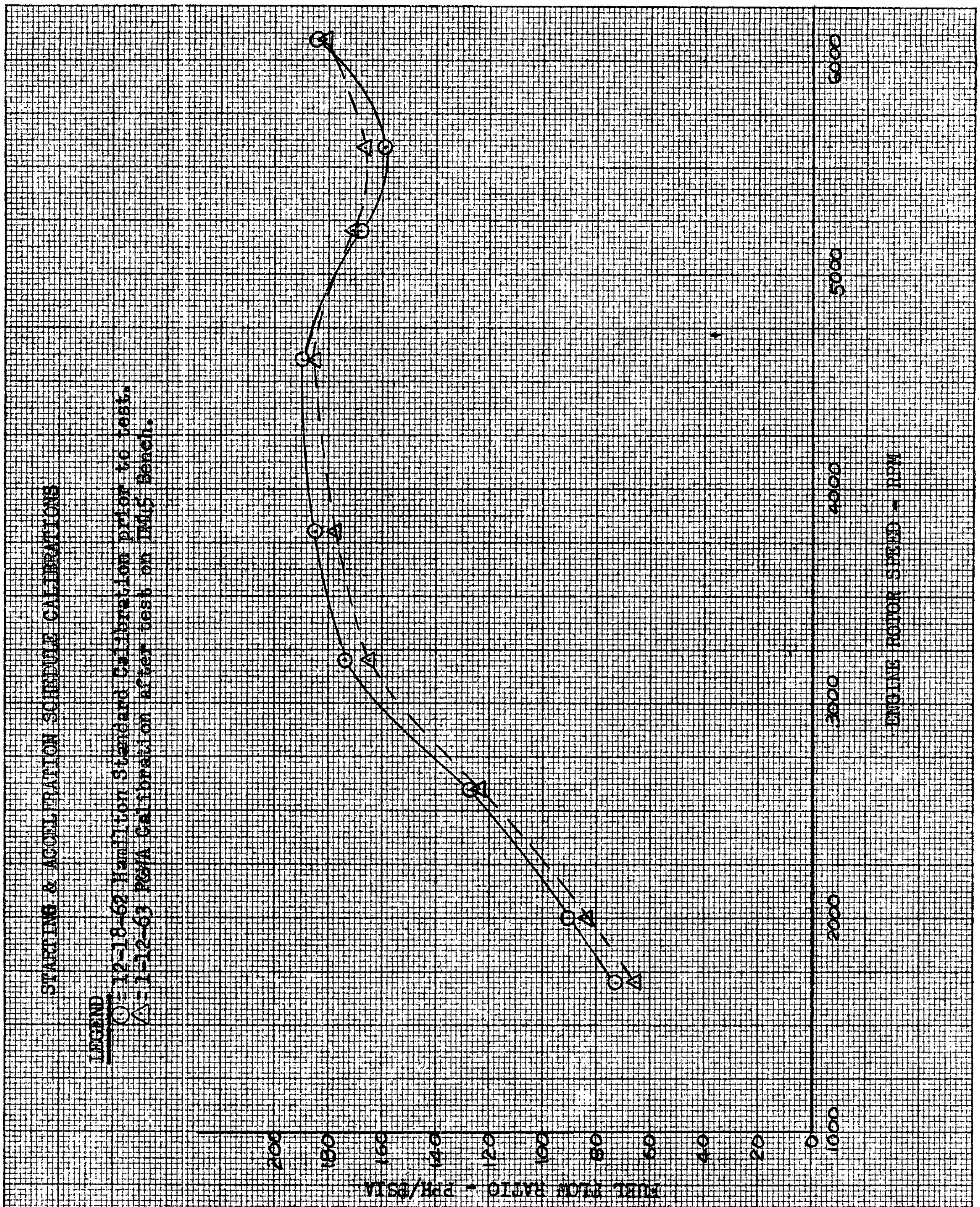
1/16/63 FX-116 FE 30619



HSD JFC-47 588300 L76/L80 Fuel Control P&WA 2072042 S/N A06A022 Bench Calibrations for Flight Suitability test.	ENG/RIG NO. FX 116 DATE 1-31-63
	TYPE YJT11D-20A DRAWN BY ACT
	STAND NO. C-4 CURVE NO. DF 2/4/6
	TEST DATE 12-28-62 thru 1-4-63

25X1

FIGURE A-12



HSD JFC-17 58#300 176/180 Main Fuel Control P&WA 207204 2 S/N A06A022 Bench Calibration for Flight Suitability test.	ENG/RIG NO. FX 116 DATE 1-31-63
[redacted]	TYPE YJT11D-20A DRAWN BY ACT
	STAND NO. C-4 CURVE NO. DF 2/4/7
	TEST DATE 12-28-62 thru 1-4-63

25X1

FIGURE A-13

COMPRESSOR SENSE SCHEDULE CALIBRATIONS

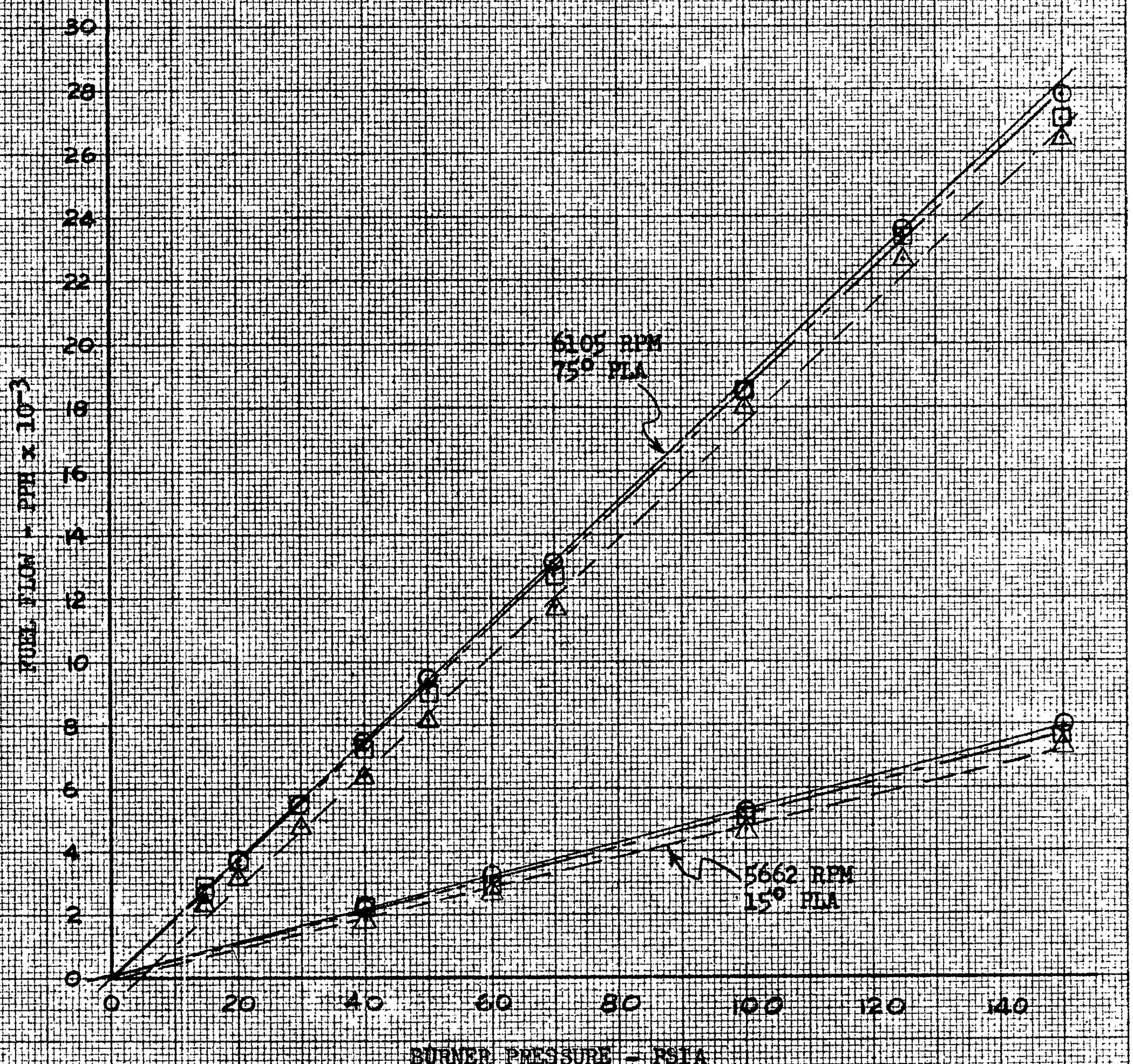
$T_{T_2} = 59^o$

LEGEND

○ 12-18-62 [redacted] Calibration prior to test. 25X1

△ 1-12-63 [redacted] Calibration after test on DM15 Bench. 25X1

□ 1-14-63 [redacted] Calibration after test on DM15 Bench after isolating regulating check valve. 25X1



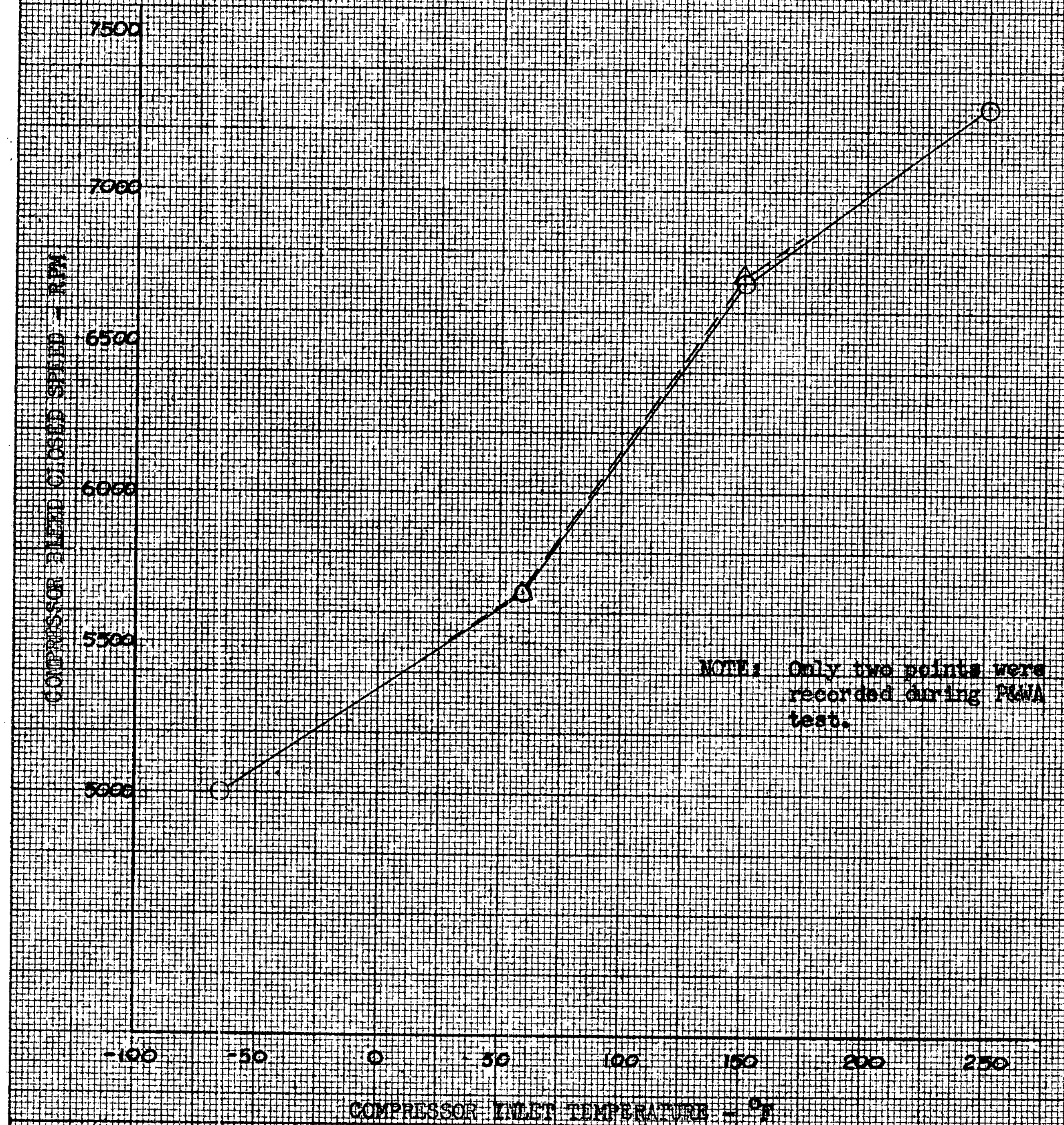
HSD JFC-47 583300 L 76/L 80 Main Fuel Control P&WA 2072042 S/N A06A022 Bench Calibration for Flight Suitability test.	ENG/RIG NO. FX 116 DATE 1-31-63
	TYPE XJT11D-20A DRAWN BY AGT
	STAND NO. C-4 CURVE NO DF 21418
[redacted]	TEST DATE 12-28-62 thru 1-4-63

2[redacted]1

FIGURE A-14

COMPRESSOR BYPASS BLEED SCHEDULE CALIBRATIONS
$T_{T_2} = 59°$

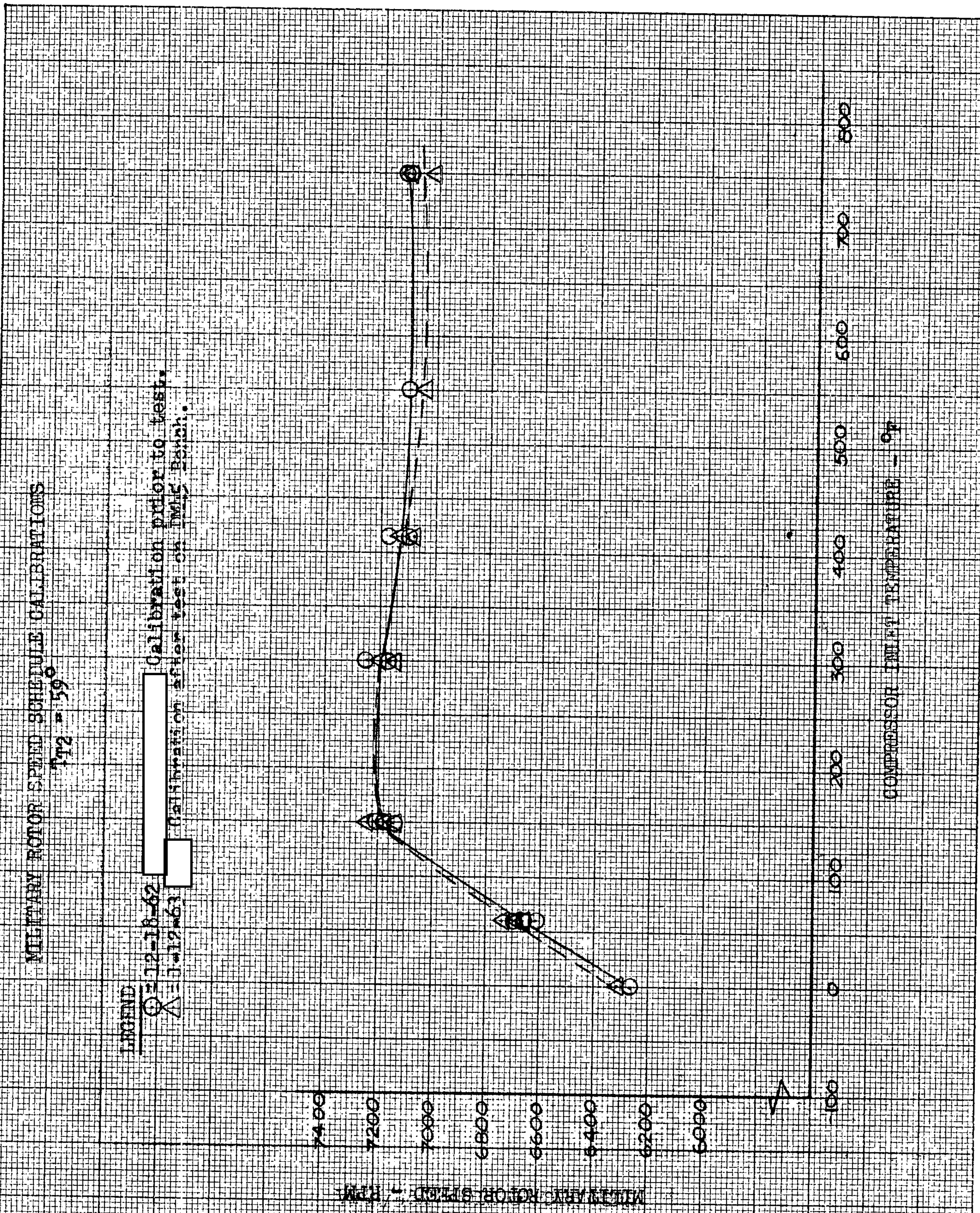
LEGEND
○ = 12-18-62 [redacted] Calibration prior to test. 25X1
△ = 1-12-63 P&WA Calibration after test on DM15 Bench.



25X1 [redacted] JFC-47 588300 L76/L80 Main Fuel Control
25X1 [redacted] 2072042 S/N A06A022 Calibrations for Flite Suitability test
25X1 [redacted]

ENG/RIG NO. FX 116	DATE 1-31-63
TYPE YJT11D-20A	DRAWN BY ACT
STAND NO. C-4	CURVE NO. DF 31419
TEST DATE 12-28-62 thru 1-1-63	

FIGURE A-15



25X1

25X1

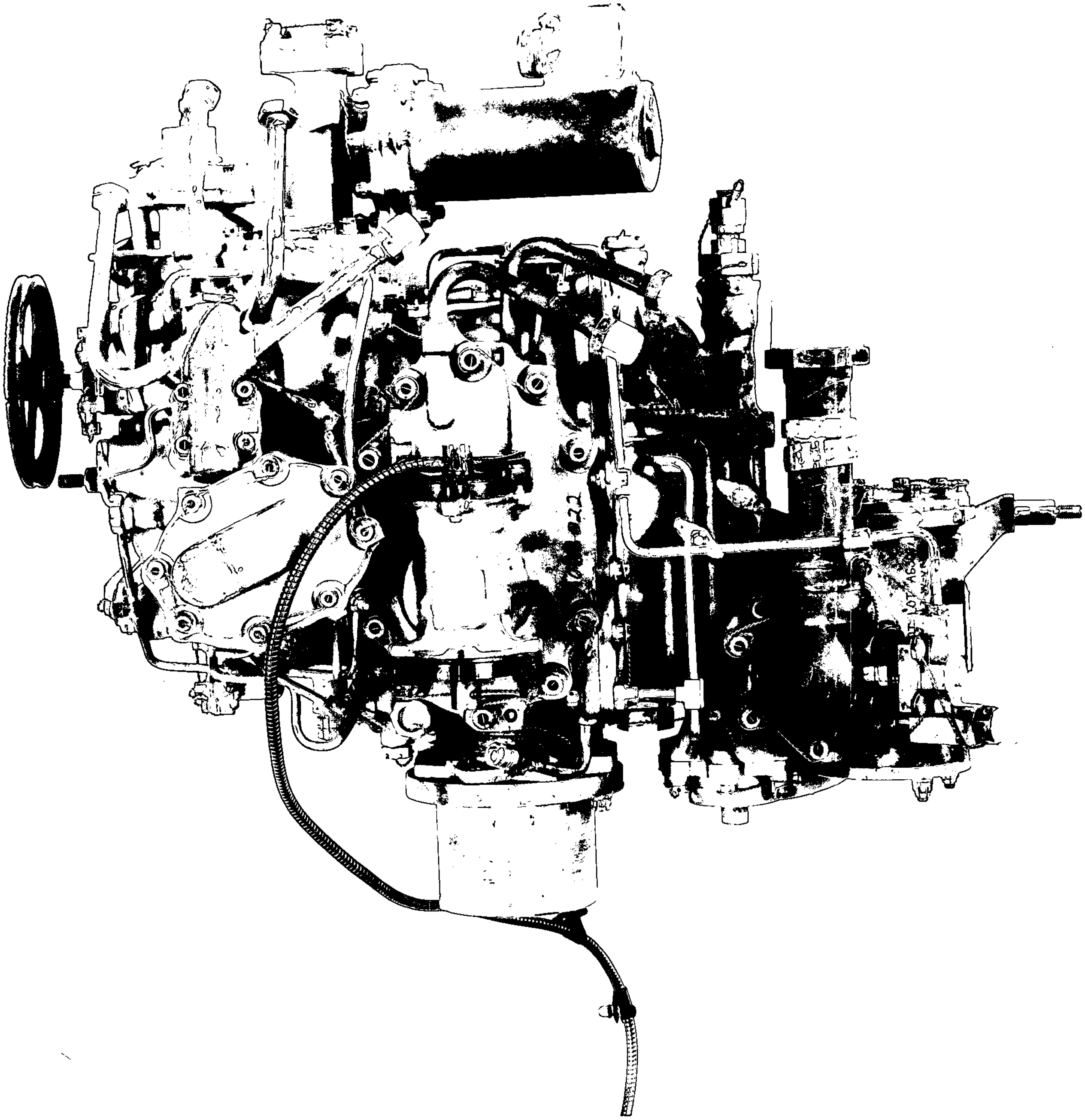
[redacted] JFC-17 588300 L76/L80 Main Fuel Control
207204 2 S/N A06A022 Bench
Calibration for Flight Suitability test.

[redacted]

ENG/RIG NO. FX 116	DATE 1-31-63
TYPE JT11D2	DRAWN BY ACT
STAND NO. C-4	CURVE NO. DF3/420
TEST DATE 12-28-62 thru 1-4-63	

25X1

25X1



25X1

FIGURE A-17

25X1
25X1

[redacted]

[redacted] JFC 47 588300 L76/L80 FUEL CONTROL, [redacted] 2072042 S/N A06A022, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 31.6 HOURS TOTAL BENCH TIME, 71.24 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 30404

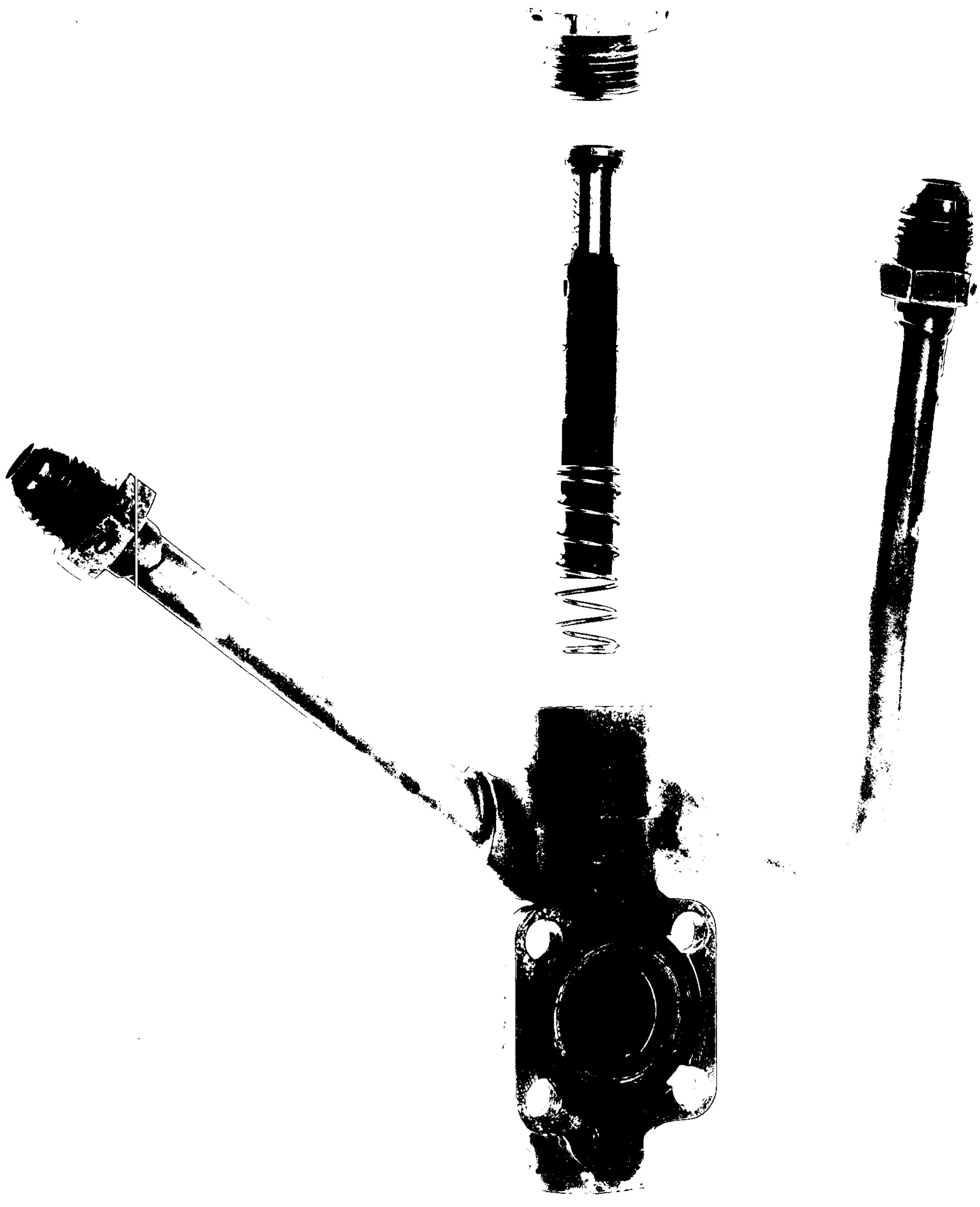
FIGURE A-19 APPROXIMATELY 3X MAGNIFICATION

25X1
25X1

[redacted]

[redacted] JFC 47 588300 L76/L80 FUEL CONTROL, [redacted] P/N 2072042, S/N A06A022, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING TRANSDUCER VALVE. 31.6 HOURS TOTAL BENCH TIME, 71.24 HOURS TOTAL ENGINE TIME. 25X1

1/31/63 FX-116 FE 30499



25X1
25X1
25X1

FIGURE A-20

[redacted] JFC 47 588300 L76/L80 FUEL CONTROL, [redacted] P/N 2072042 S/N A06A022, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING TRANSDUCER VALVE ASSEMBLY. 31.6 HOURS TOTAL BENCH TIME, 71.24 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 30711

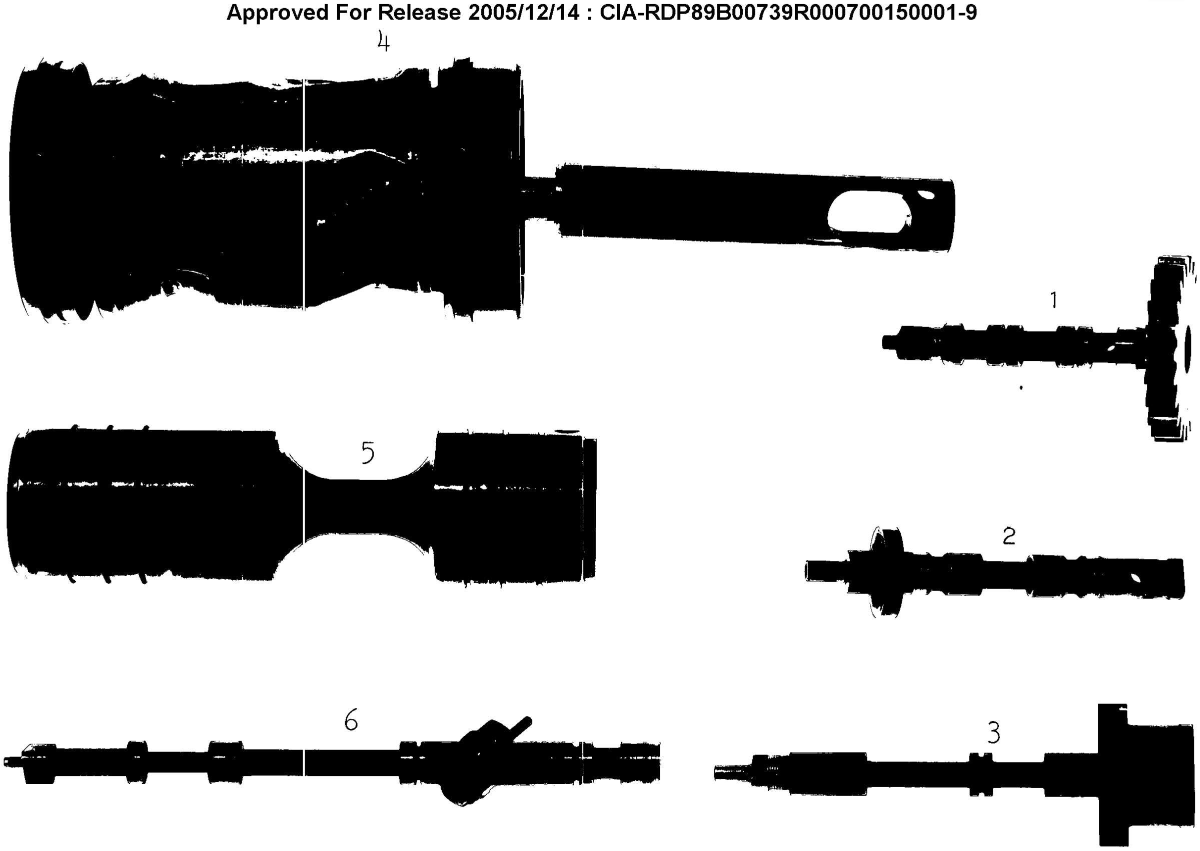
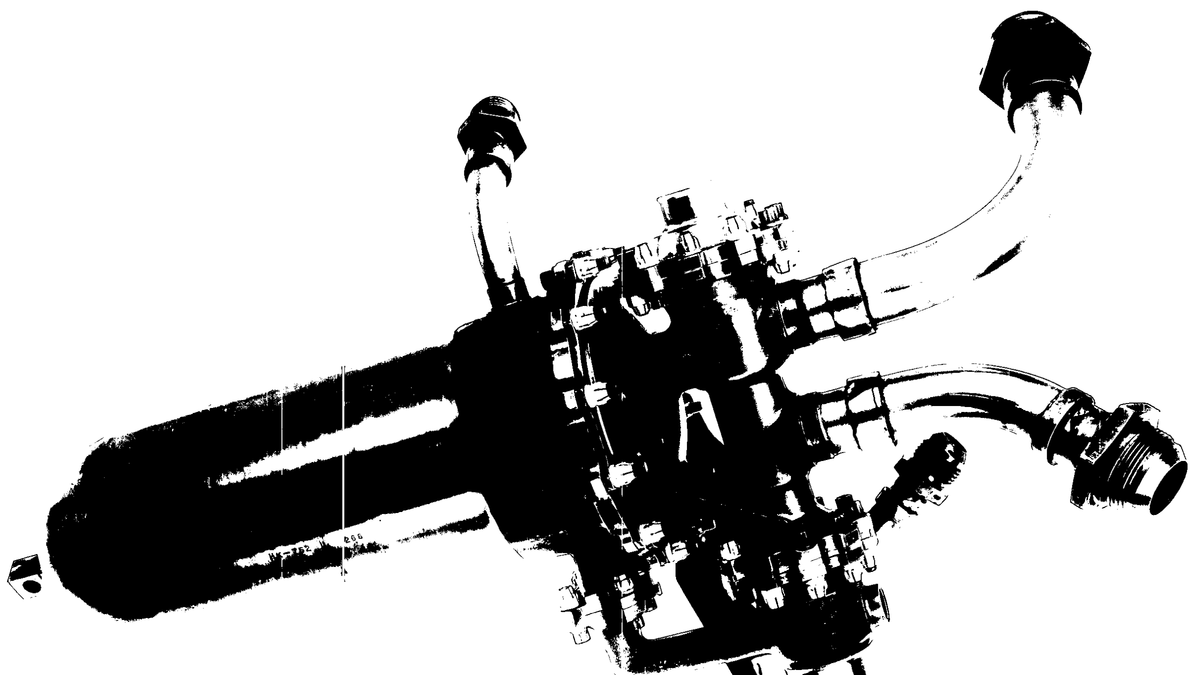


FIGURE -21

25X1
25X1

[redacted]

[redacted] JFC-47 588300 L76/L80 FUEL CONTROL,
[redacted] 2072042 S/N A06A022, AFTER FLIGHT SUITABILITY TEST
ON YJT11D-20A ENGINE FX-116 SHOWING (1) TEMP SERVO PILOT
VALVE (2) SPEED SERVO PILOT VALVE (3) METERING VALVE PILOT
VALVE (4) SPEED TEMP CAM AND PUSH ROD (5) REGULATING VALVE
(6) REGULATING VALVE PILOT VALVE. 31.6 HOURS TOTAL BENCH
TIME, 71.24 HOURS TOTAL ENGINE TIME.
1-31-63 FX-116 FE30712



25X1

25X1

[redacted]

FIGURE A-22

[redacted] MAIN ENGINE FUEL OIL COOLER 2046443 S/N A-23A-013 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 97.35 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 31234

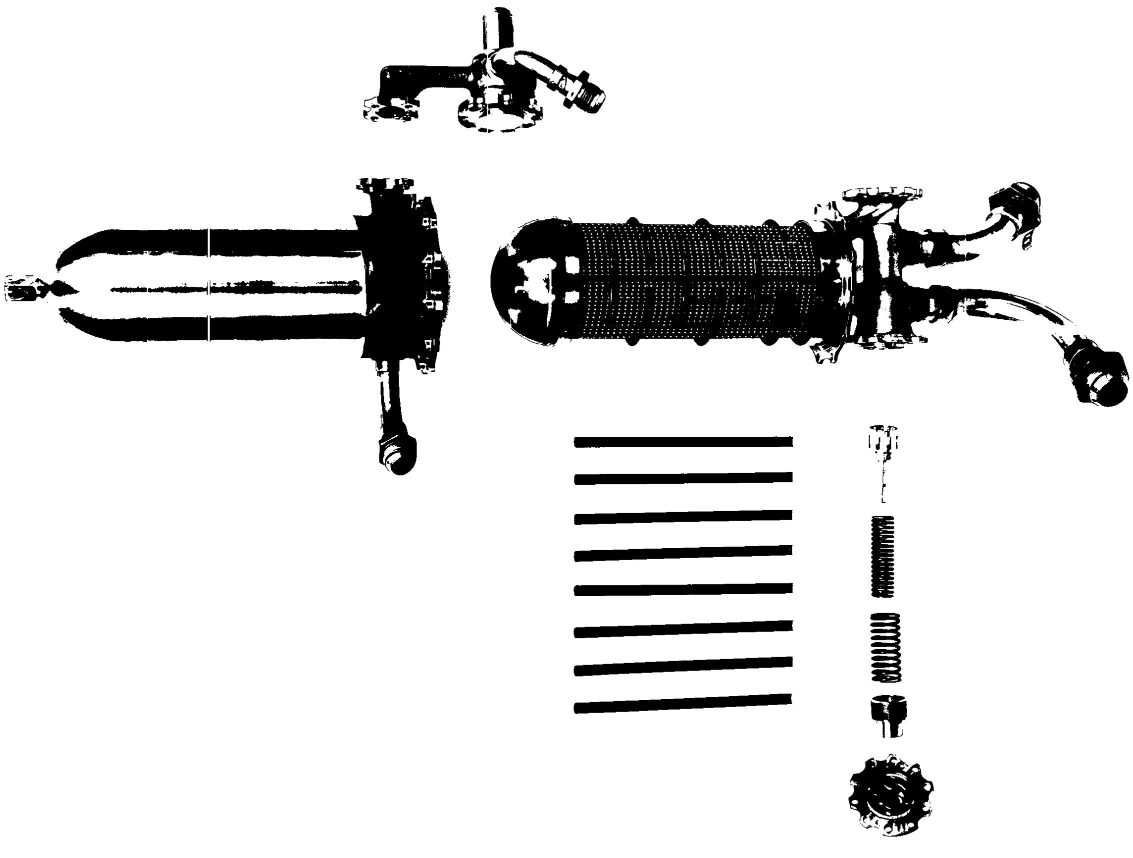
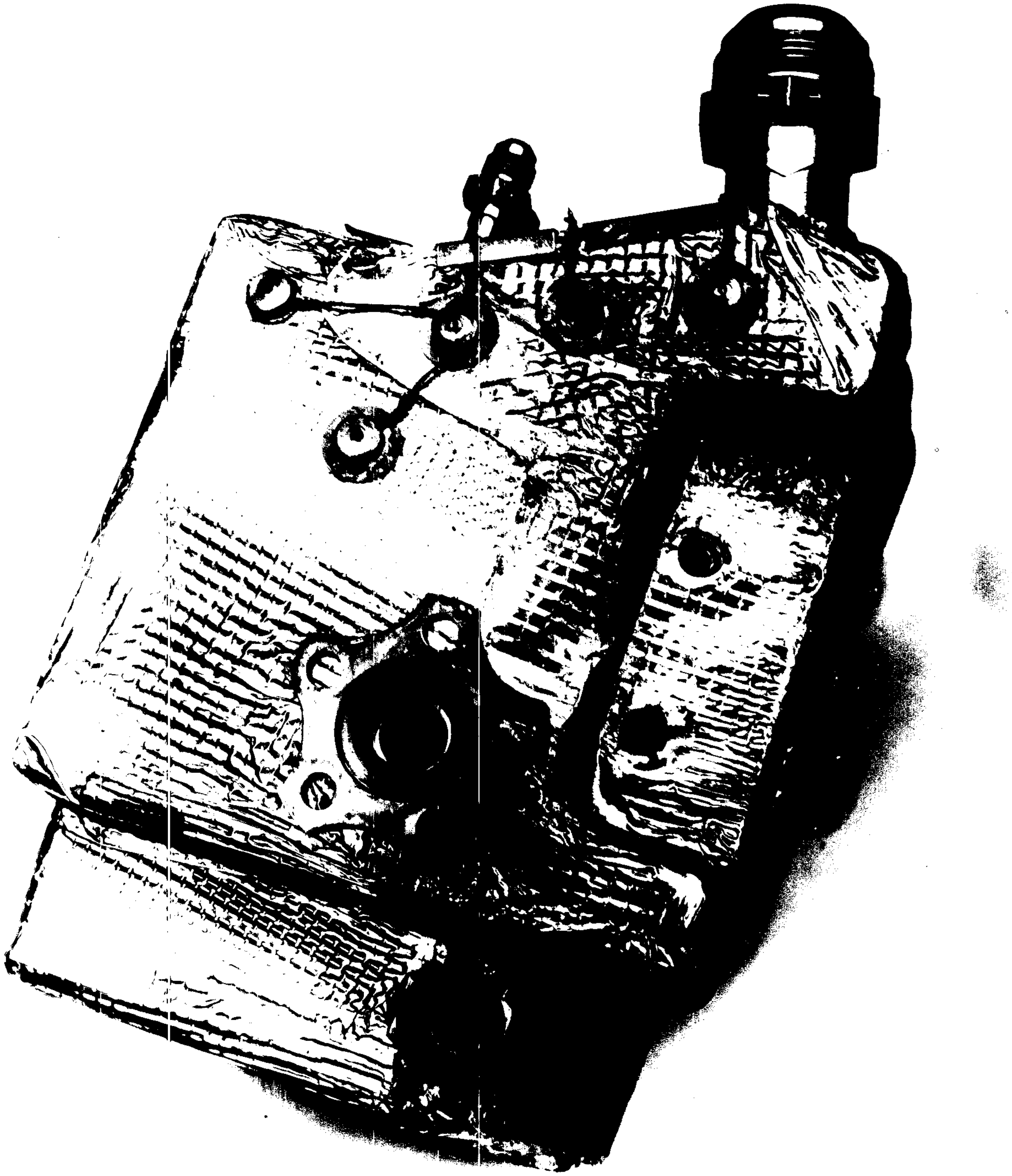


FIGURE A-23

25X1
25X1

[redacted] MAIN ENGINE FUEL OIL COOLER
P/N 2046443 S/N A-23A-013 AFTER FLIGHT SUITABILITY TEST
ON YJT11D-20A ENGINE FX-116. 97.35 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 30751



25X1
25X1

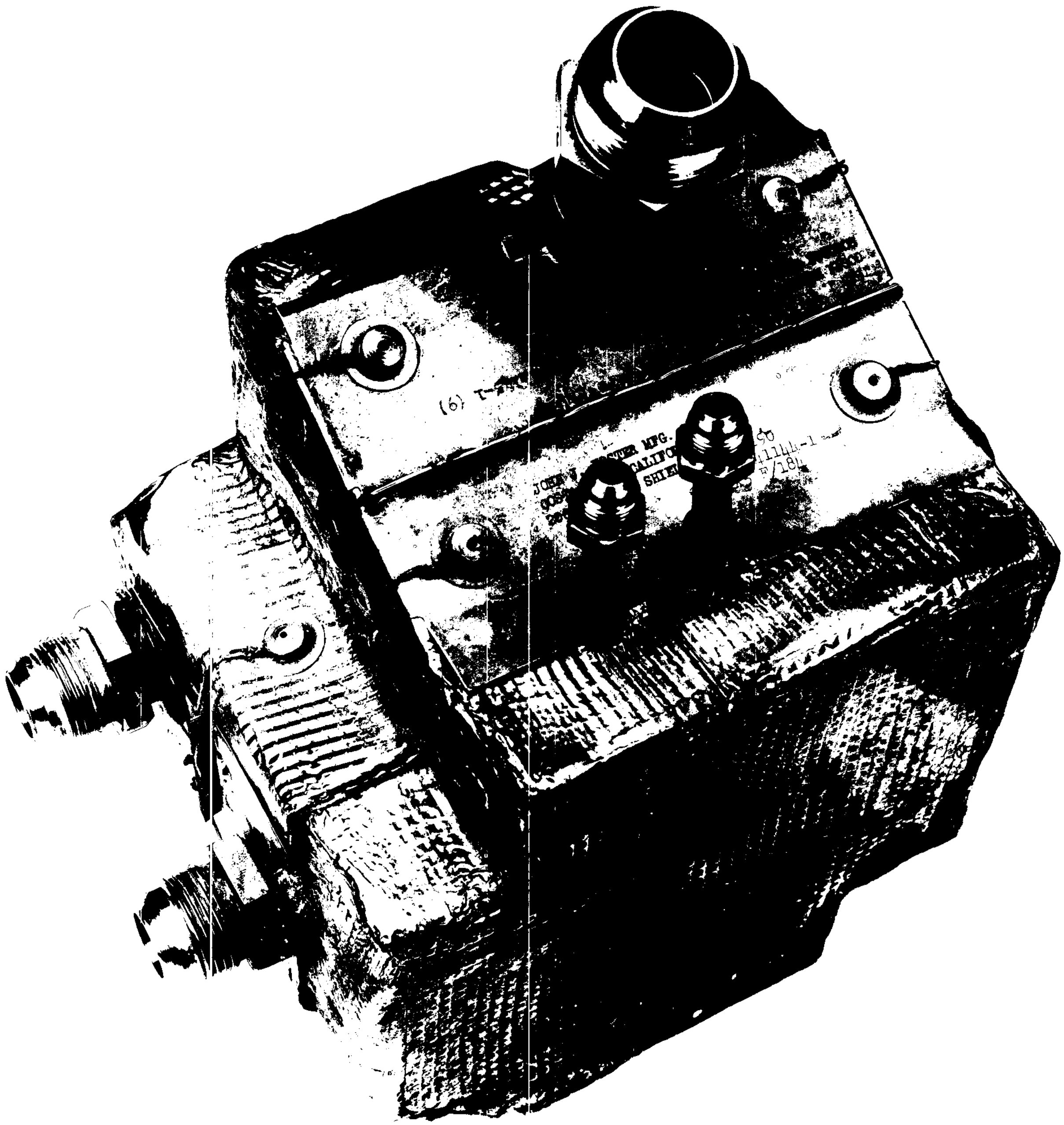
[redacted]

FIGURE A-24

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK, AND DUMP VALVE, [redacted] 2050986 S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 WITH [redacted] HEAT SHIELDING INSTALLED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

25X1

1/30/63 FX-116 FE30486



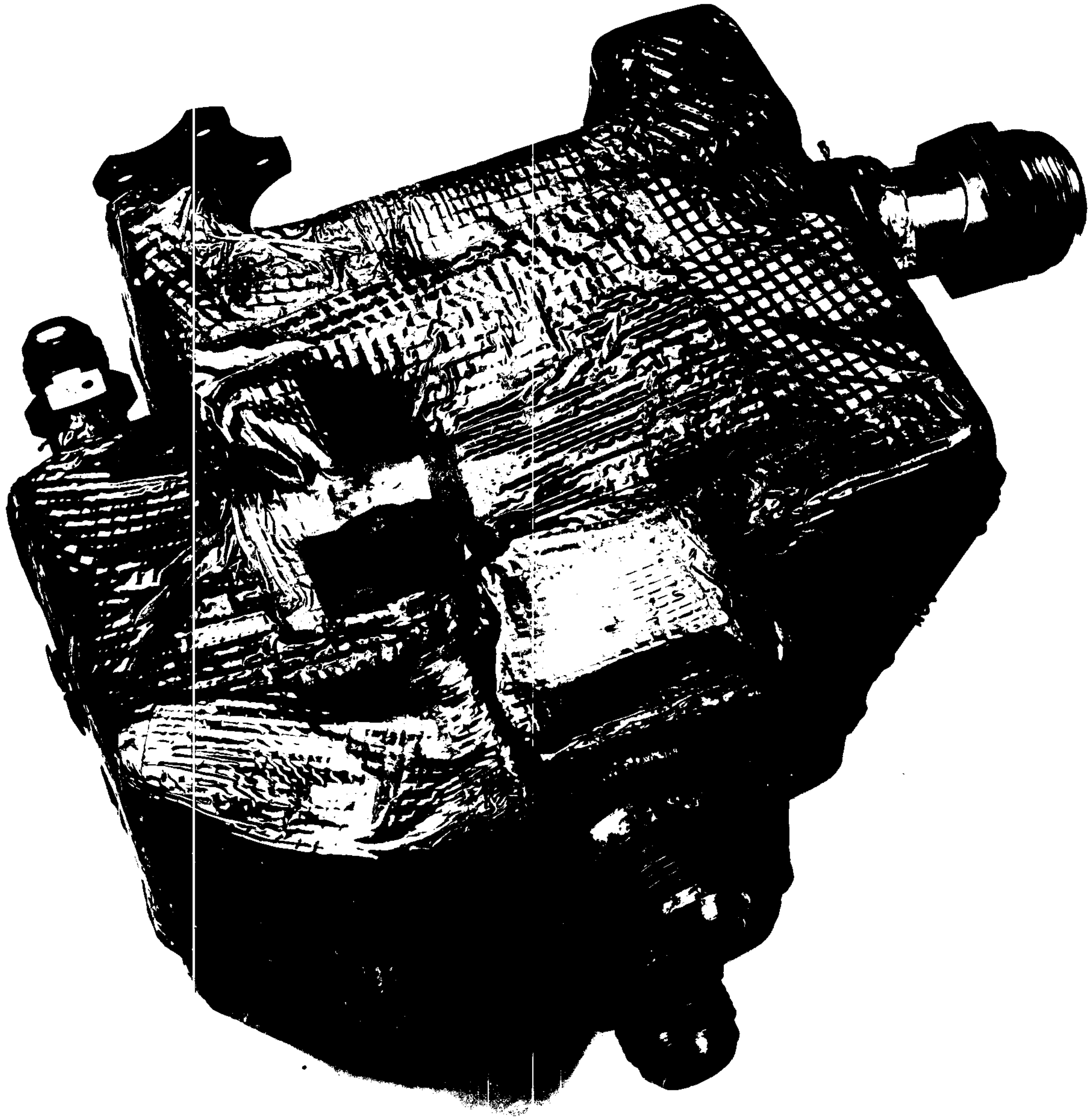
25X1

FIGURE A-25

25X1 [redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. WITH [redacted] HEATSHIELDING INSTALLED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

25X1

1/30/63 FX-116 FE 30487



25X1

FIGURE A-26

25X1 [redacted]

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20 ENGINE FX-116. WITH [redacted] HEATSHIELDING INSTALLED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

25X1

1/30/63 FX-116 FE 30488

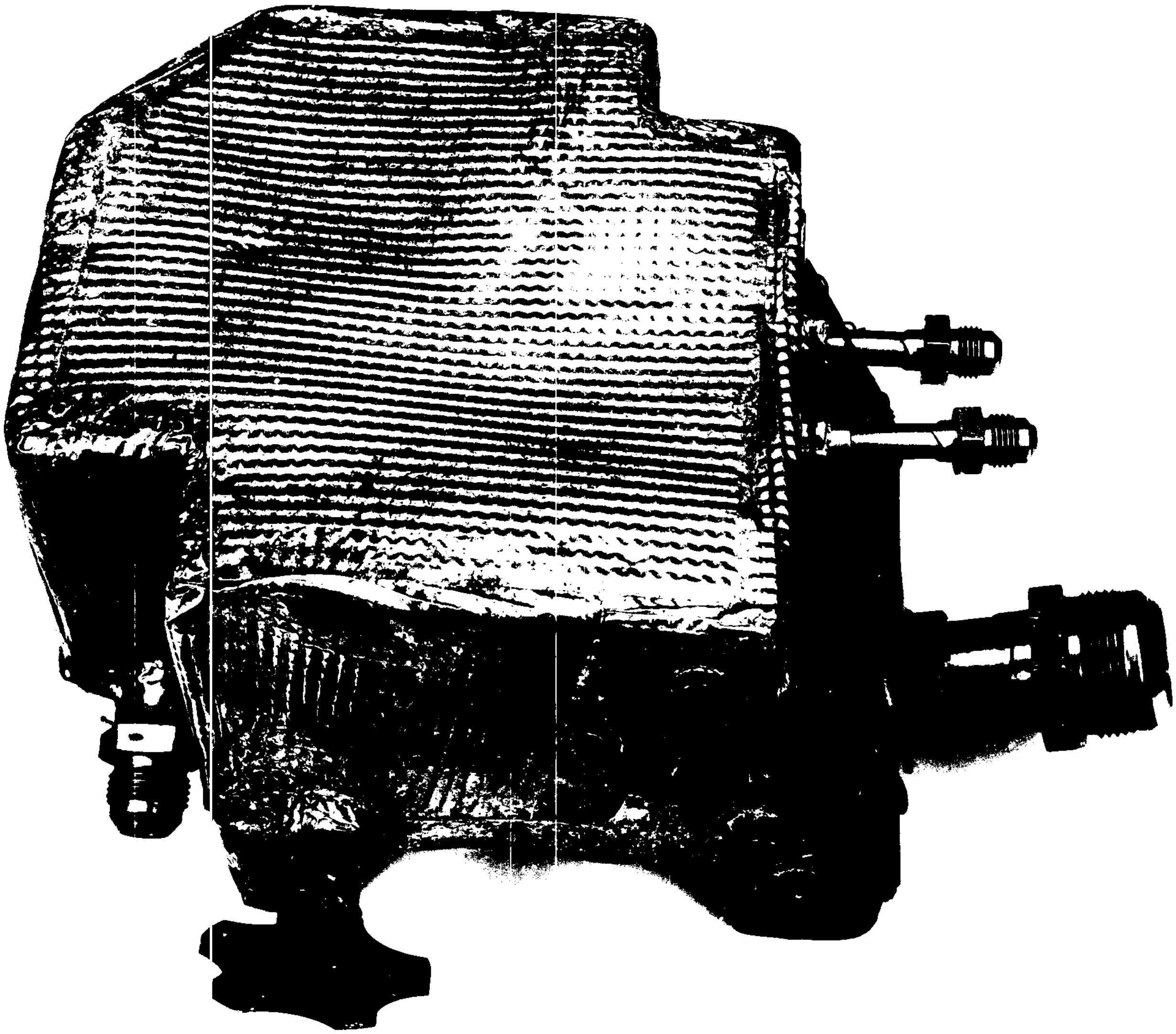
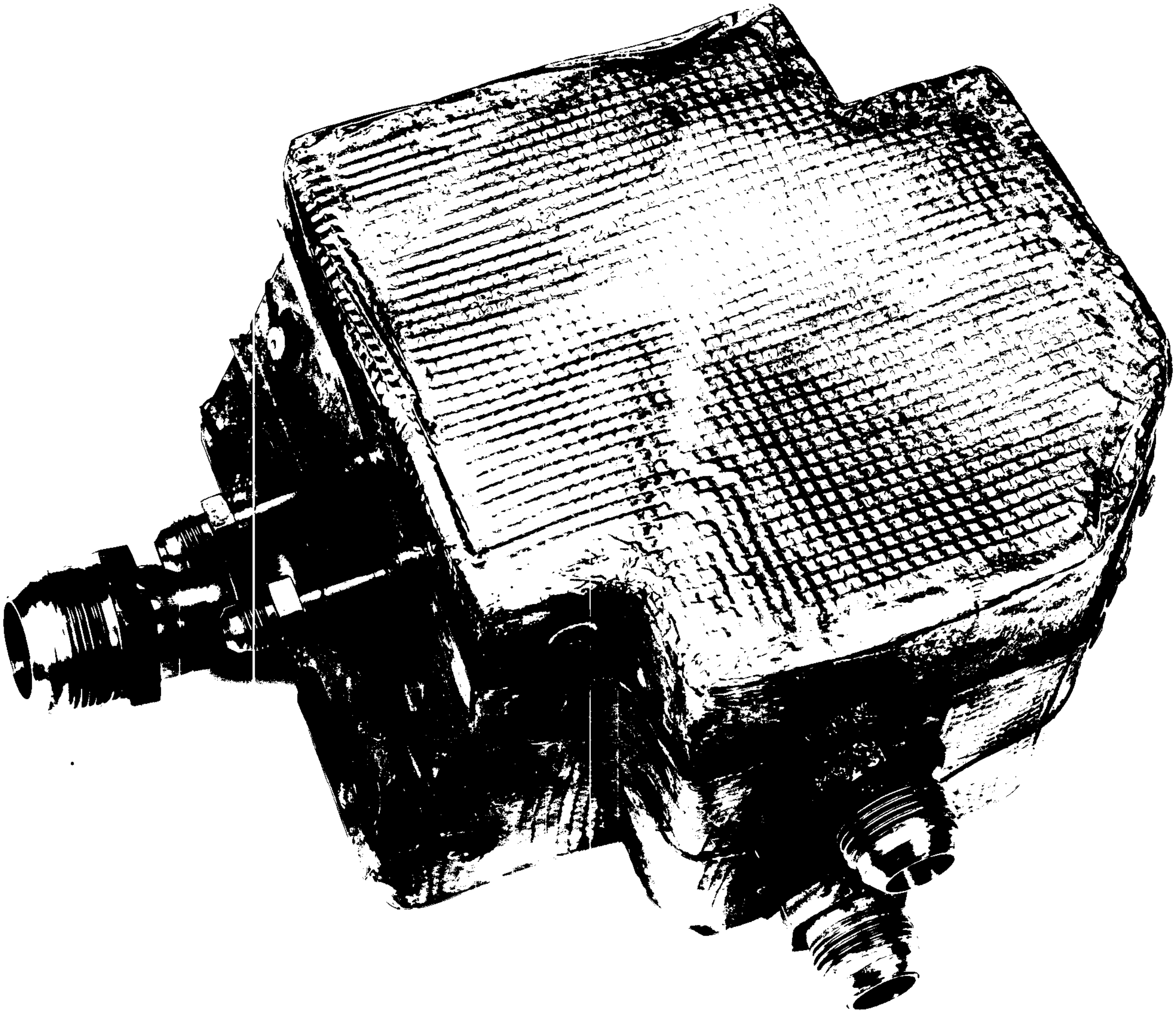


FIGURE A-27

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116.WITH [redacted] HEATSHIELDING INSTALLED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 30489



25X1

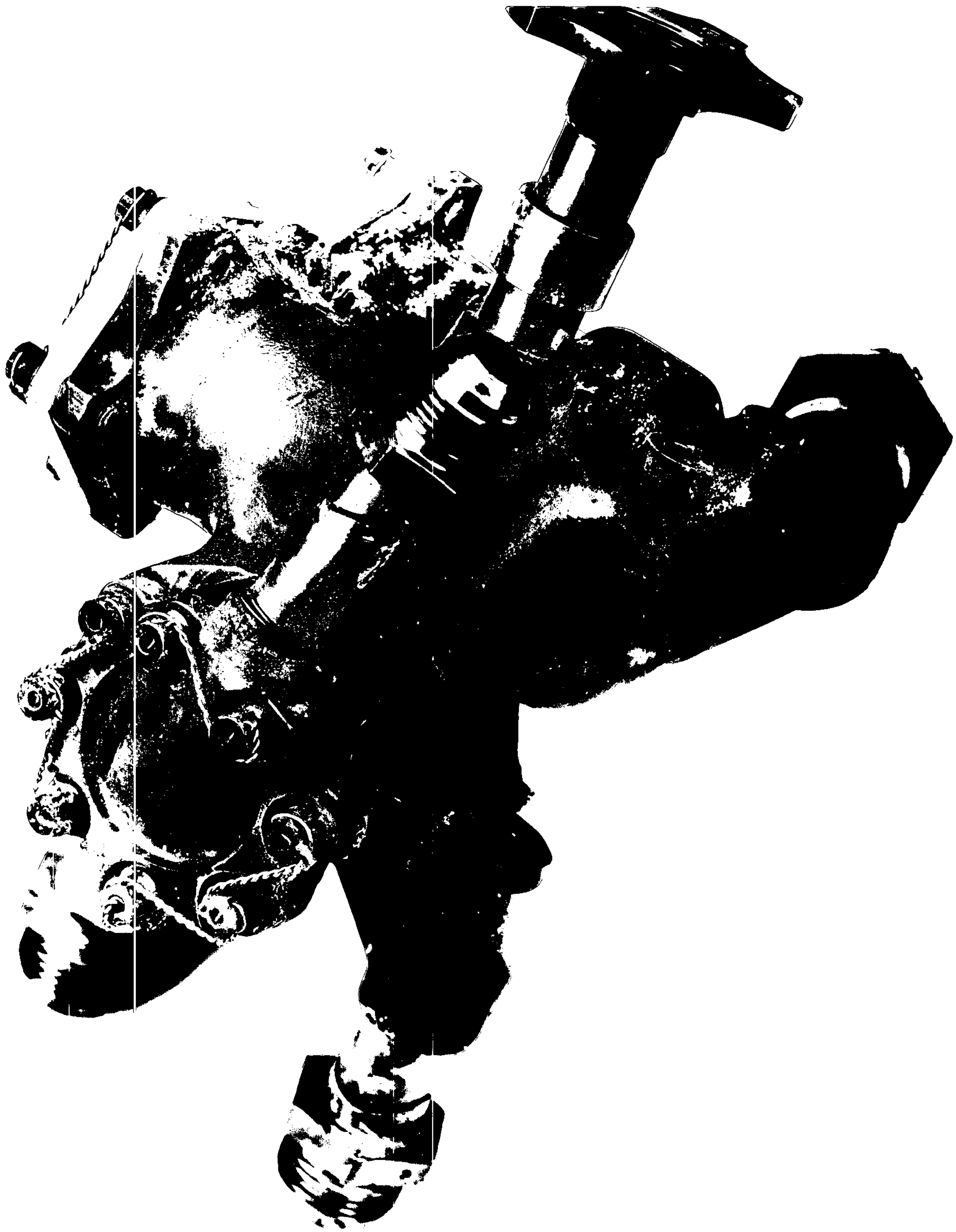
FIGURE A-28

25X1 [redacted]

25X1

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. WITH [redacted] HEATSHIELDING INSTALLED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 30490



25X1

FIGURE A-29

25X1 [redacted]

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. WITH HEATSHIELDING REMOVED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 30491

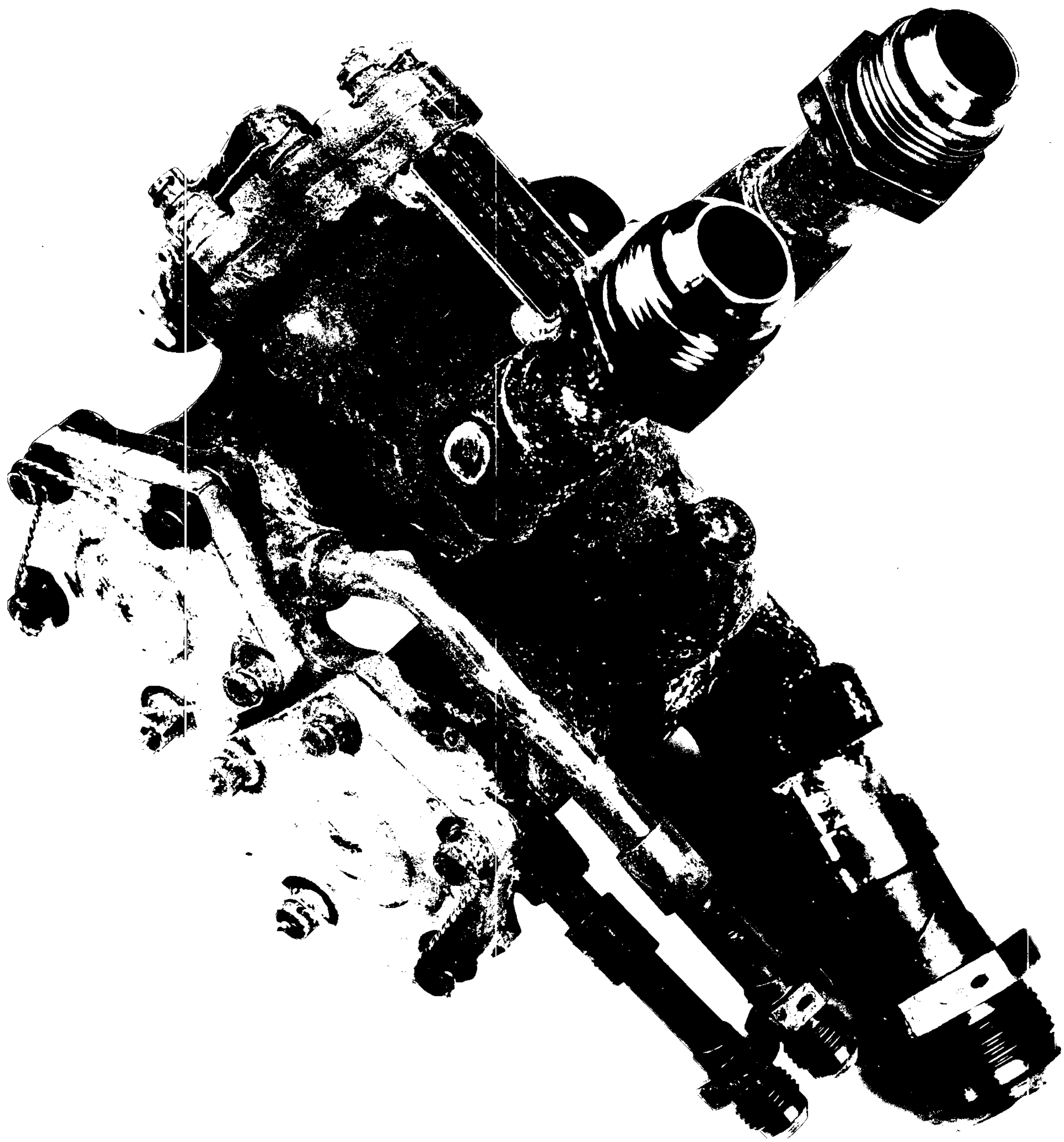
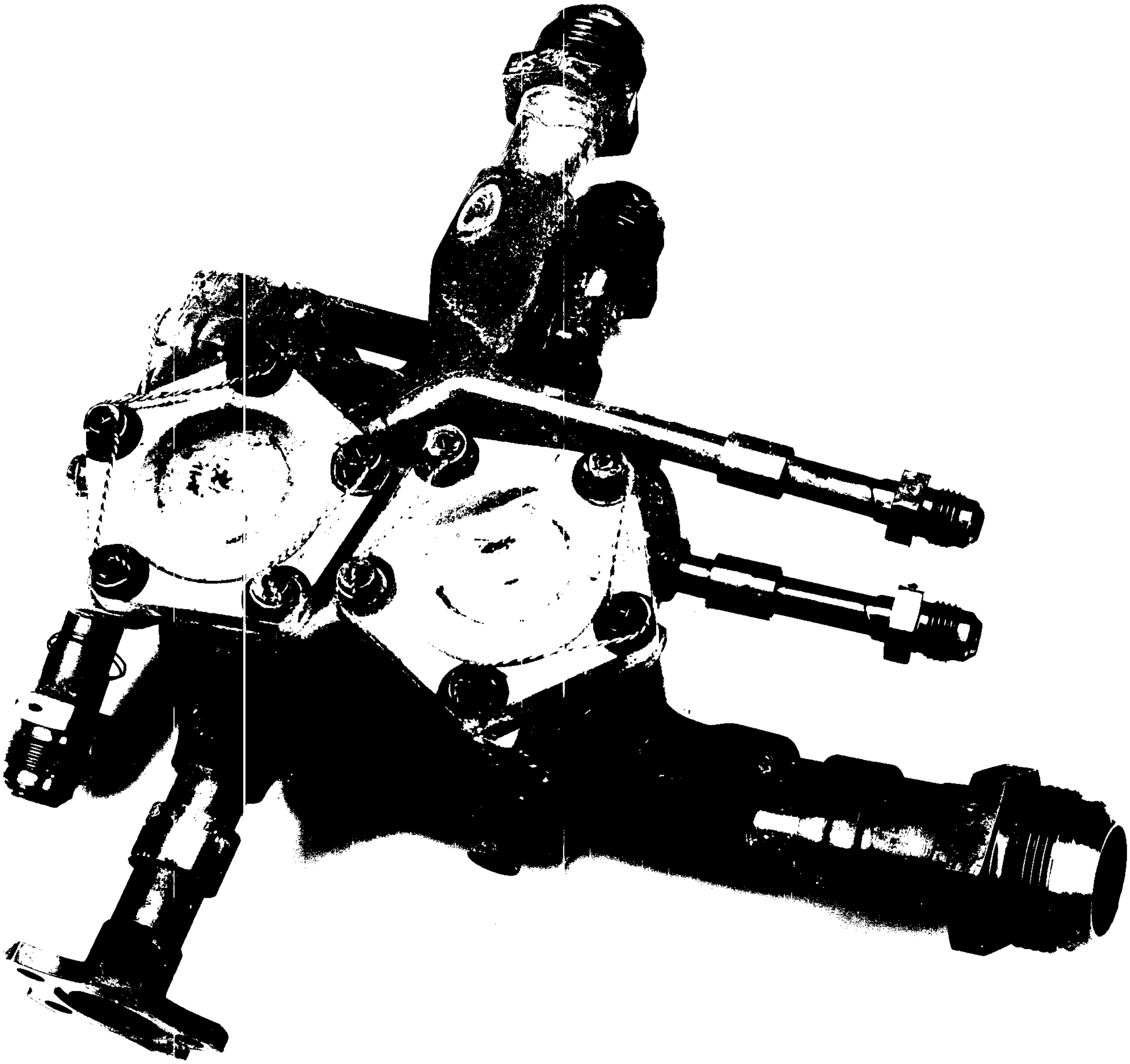


FIGURE A-30

25X1

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. WITH HEATSHIELDING REMOVED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 30492



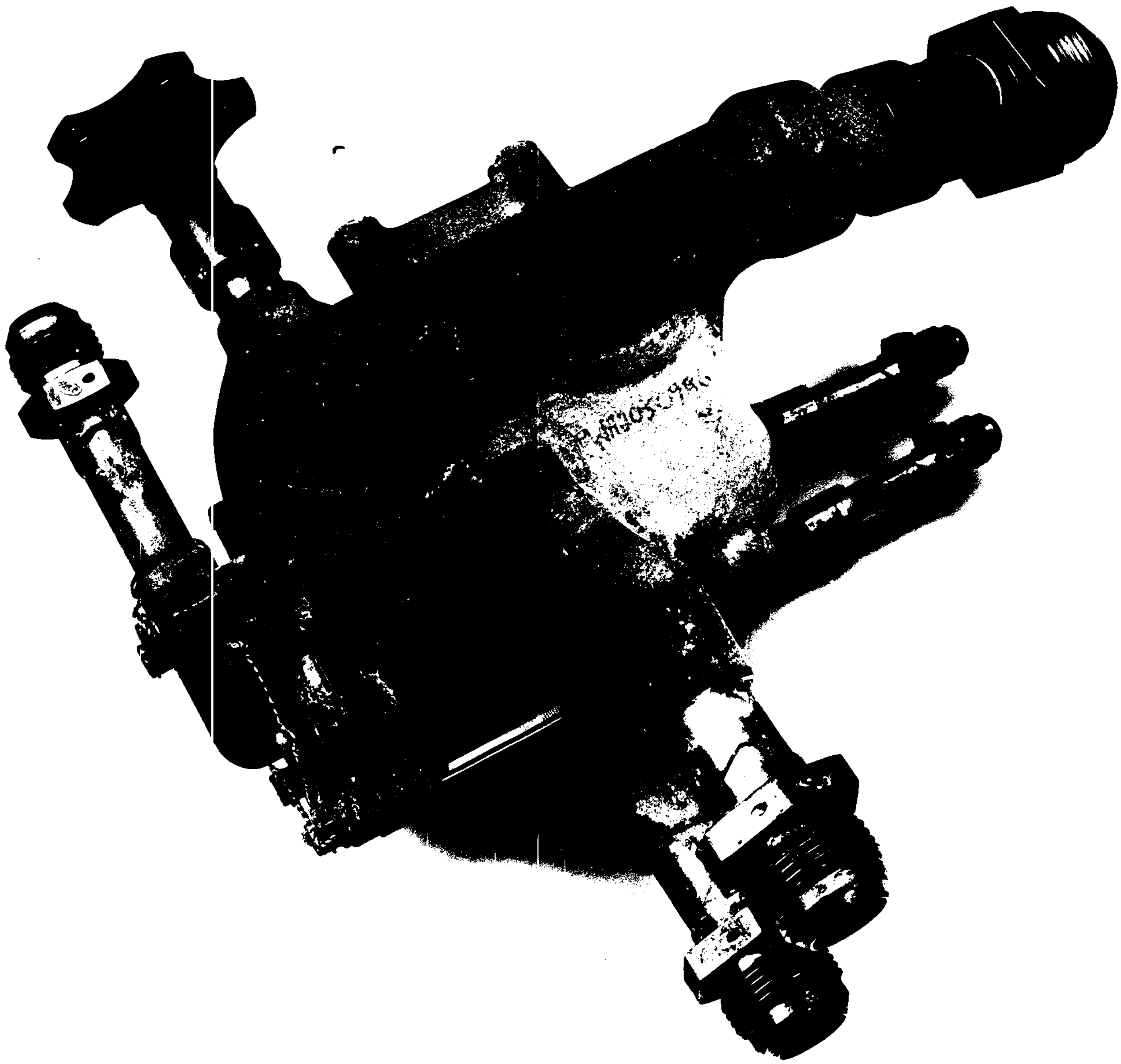
25X1

FIGURE A-31

25X1 [redacted]

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. WITH HEATSHIELDING REMOVED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 30493



25X1

25X1

FIGURE A-32

[redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 25X1

HEATSHIELDING REMOVED. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30494

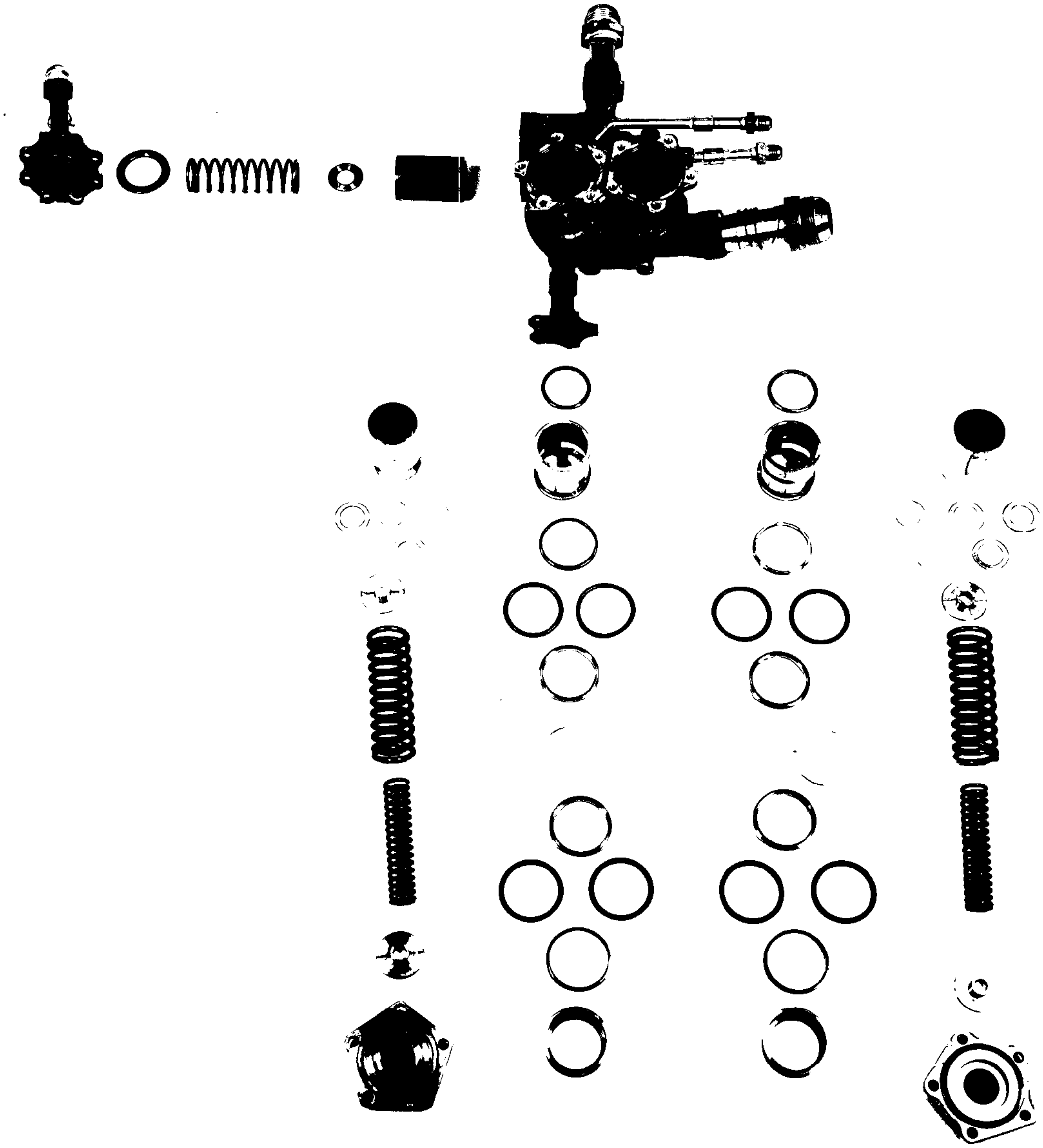
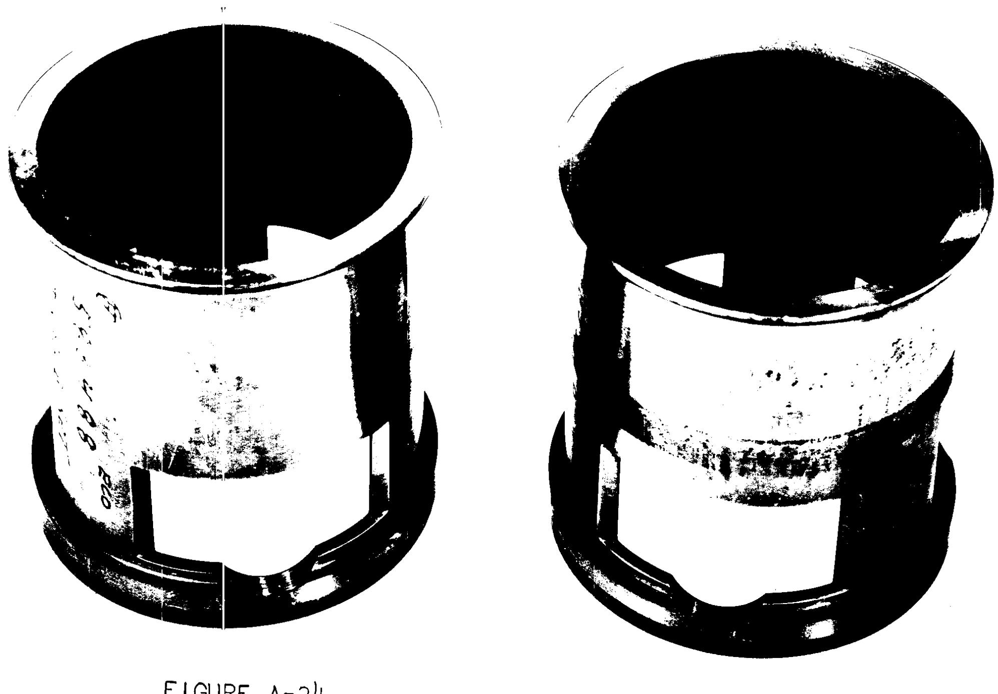


FIGURE A-33

25X1 [redacted] [redacted] 576497L7 WINDMILL BYPASS, SHUTOFF, CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 30752



25X1
25X1
25X1

[redacted]

FIGURE A-34

APPROXIMATELY 1.5X MAGNIFICATION

[redacted] 576497L7 WINDMILL BYPASS SHUTOFF CHECK AND DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING BYPASS AND SHUTOFF VALVE SLEEVE. 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/30/63

FX-116

FE 31196

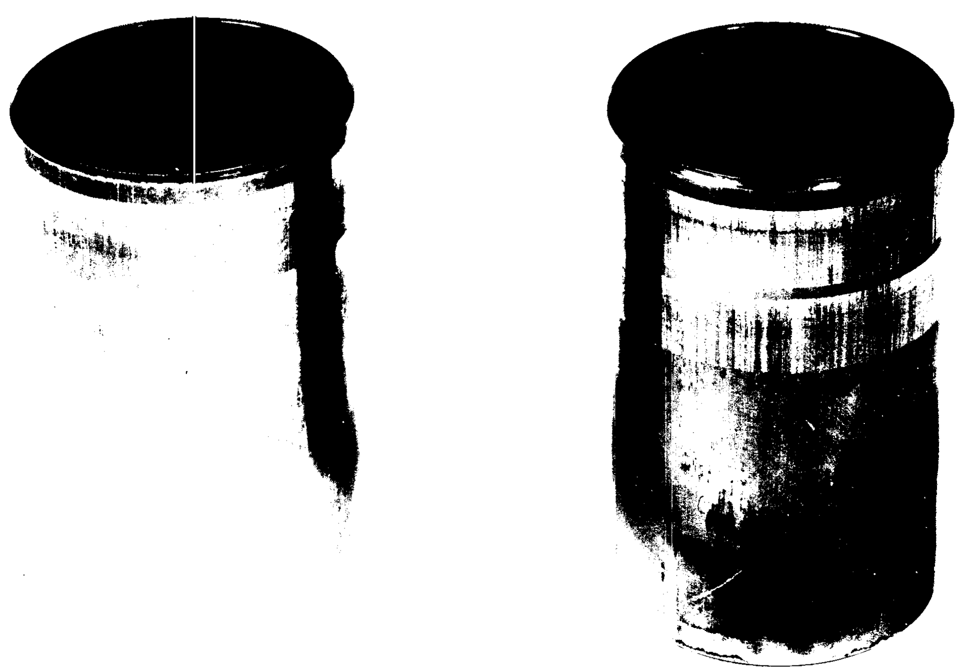


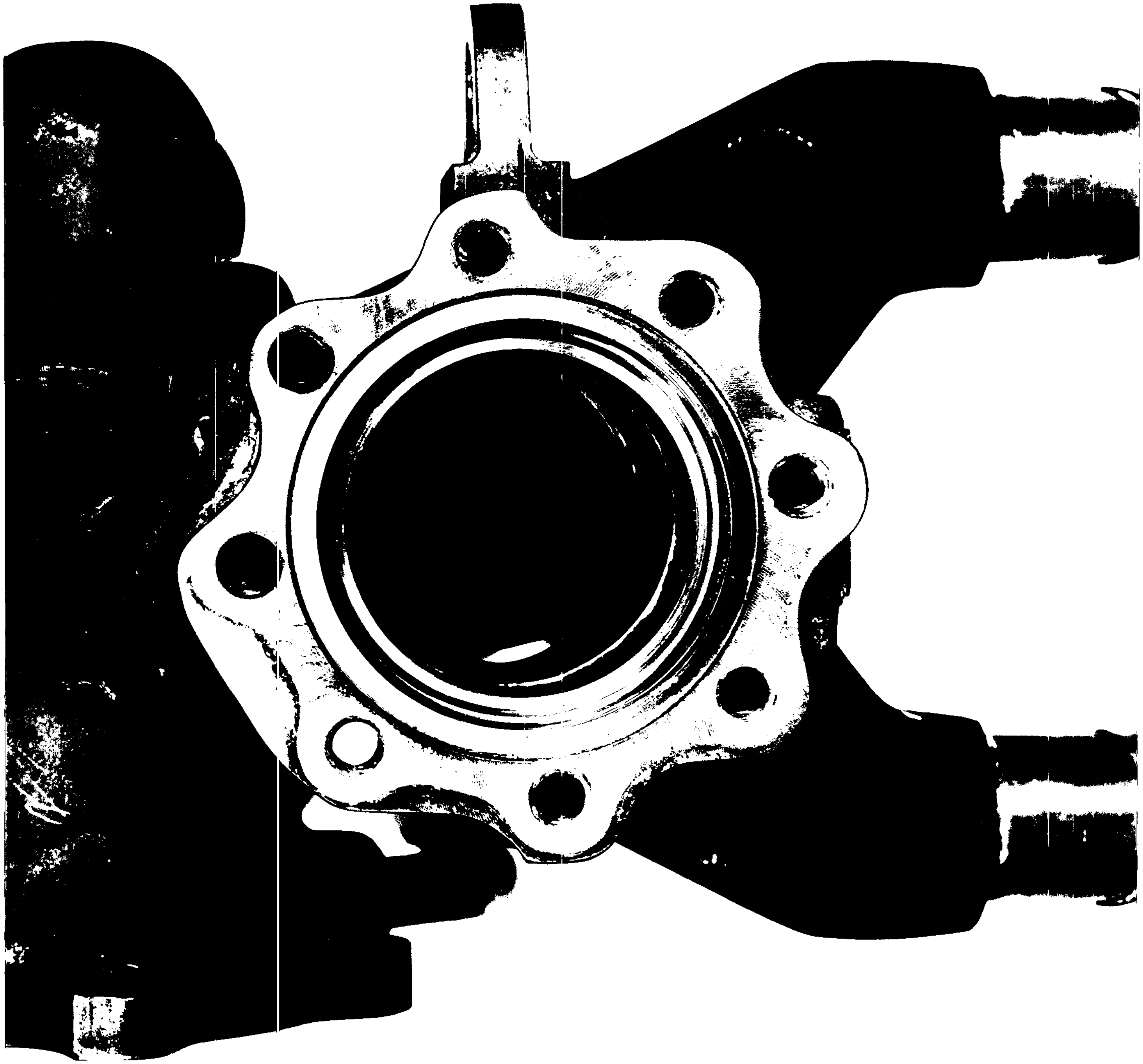
FIGURE A-35 APPROXIMATELY 1.5X MAGNIFICATION

25X1
25X1
25X1

[redacted]

[redacted] 576497L7 WINDMILL BYPASS SHUTOFF CHECK & DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING BYPASS, SHUTOFF AND CHECK & DUMP PISTONS, 8.66 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 31197

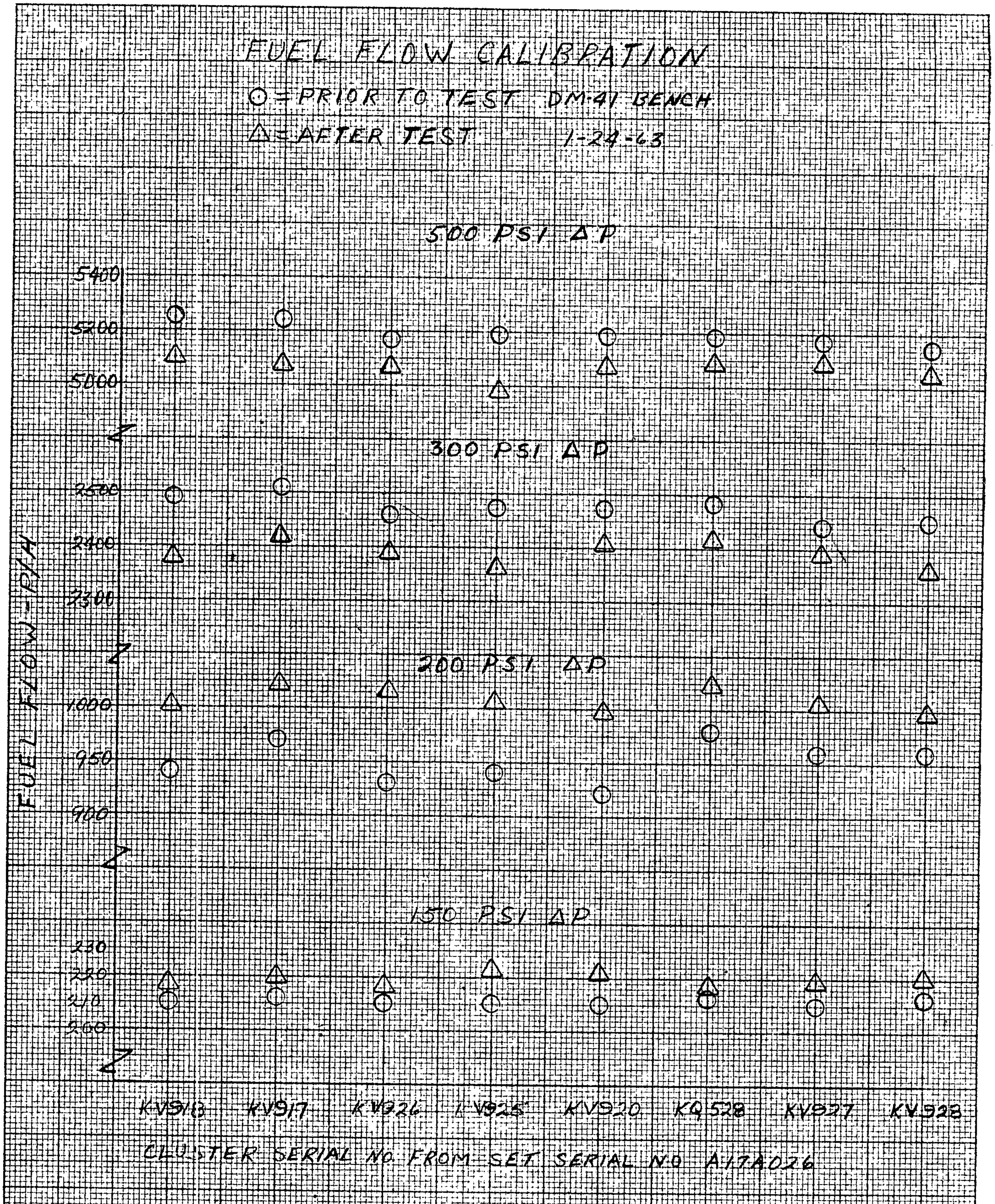


25X1

FIGURE A-36 APPROXIMATELY 1.5X MAGNIFICATION

25X1 [redacted] 576497 L7 WINDMILL BYPASS SHUTOFF CHECK & DUMP VALVE, [redacted] 2050986, S/N A46A014, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20 ENGINE FX-116 SHOWING CHECK & DUMP VALVE HOUSING BASE. 8.66 HOURS TOTAL BENCH TIME , 97/35 HOURS TOTAL ENGINE TIME. 25X1

1/30/63 FX-116 FE 31198

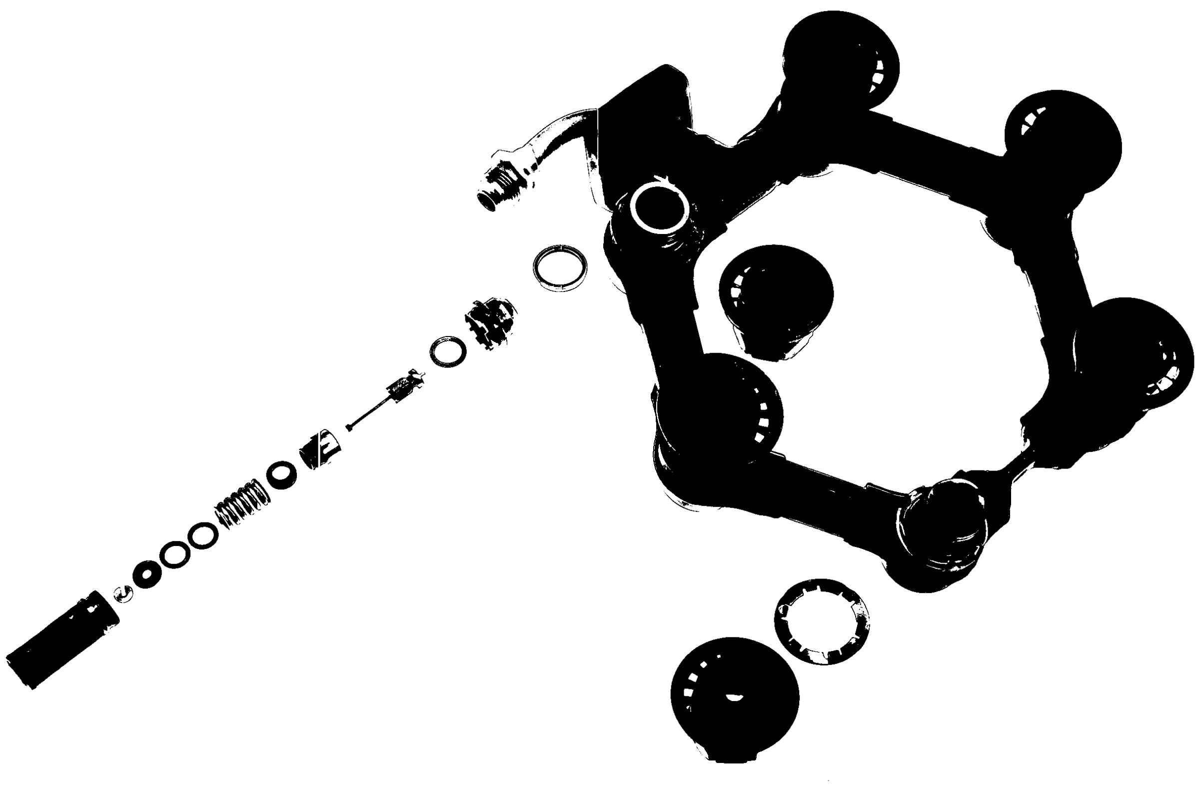


25[redacted]1
25[redacted]1

INTERNAL FUEL MANIFOLD ASSY'S 206B359 SET S/N A17A026 FLOW CALIBRATION'S FOR FLIGHT SUITABILITY TEST

ENG/RIG NO EX-116	DATE 1-31-63
TYPE YJT11D-20A	DRAWN BY DKS
STAND NO C4	CURVE NO DF 21437
TEST DATE 12-28-62 THRU 1-4-63	

FIGURE A-37



25X1
25X1

FIGURE A-38

[redacted] INTERNAL FUEL MANIFOLD ASSEMBLY 2068360 KG 528 FROM SET S/N A17A026, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 97.35 HOURS TOTAL ENGINE TIME.

1/28/63 FX-116 FE 31007

[redacted]

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9

	Before Test D-32 12-14-62	After Test D-32 1-15-63
Main Hi Seal Leakage	0 cc N_2/3min	0 cc N_2/3min
A/B Hi Seal Leakage	0 cc N_2/3min	0 cc N_2/3min
Main Servo-Shaft Leakage	0 cc N_2/3min	0 cc N_2/3min
Dump Shaft Leakage	0 cc Fuel/min	0 cc Fuel/min
Main Chevron Leakage	0 cc Fuel/min	0 cc Fuel/min
A/B Chevron Leakage	0 cc Fuel/min	0 cc Fuel/min
A/B Minimum Sense Pressure For TEB Shot	80 PSI Δ P	70 PSI Δ P
Main Minimum Sense Pressure For TEB Shot	45 PSI Δ P	50 PSI Δ P
Dump Sense Pressure	150 PSI Δ P	150 PSI Δ P
Main Shot Volume (5 Shots)	44 cc 46 cc 43 cc 45 cc 44 cc	45 cc 47 cc 46 cc 48 cc 48 cc
A/B Shot Volume (5 Shots)	49 cc 46 cc 49 cc 44 cc 49 cc	51 cc 52 cc 52 cc 53 cc 53 cc
Needle Valve Leakage	0 Bubbles/min	0 Bubbles/min

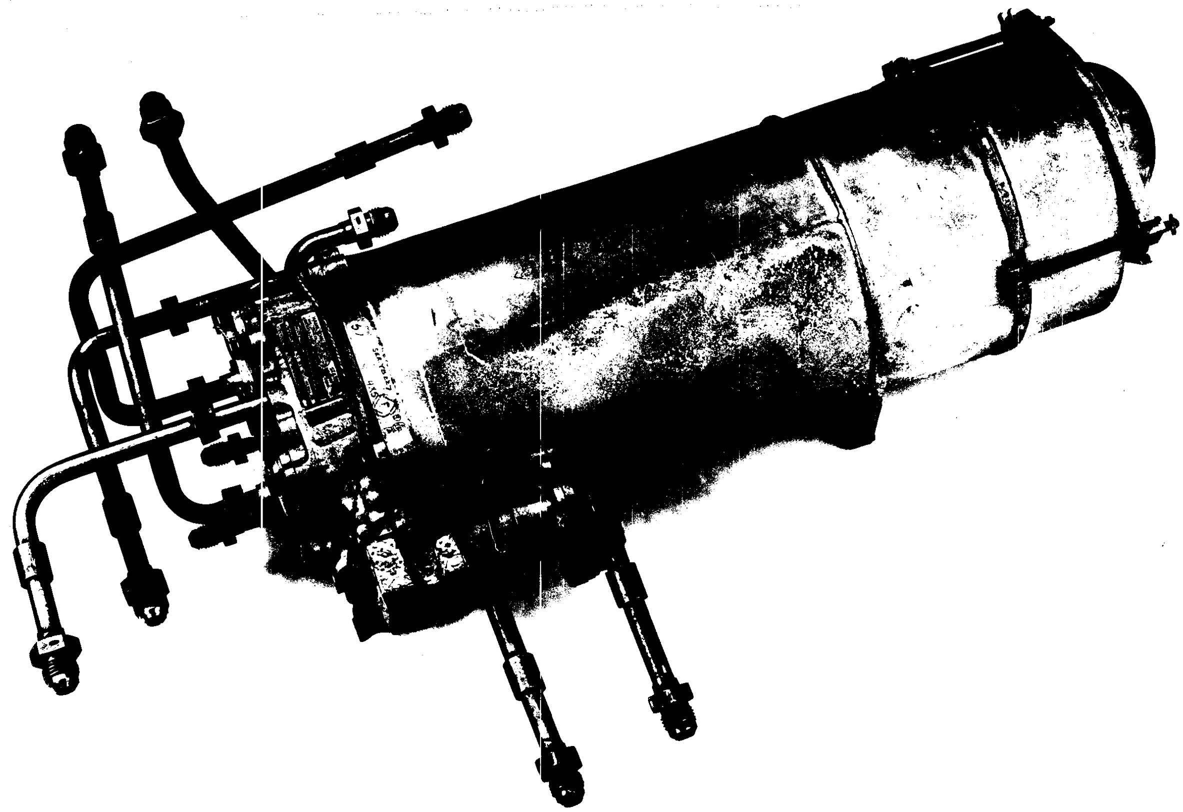
25X1
25X1
25X1

[redacted] 5742/2L-12 Chemical Ignition Control
[redacted] 2057541 S/N A11A028
Bench Calibrations for Flight Suitability
[redacted]

ENG/RIG NO. EX-116 DATE 1-30-63
TYPE YJ110-20A DRAWN BY D.M.G.
STAND NO. C-4 CURVE NO. DF-21399
TEST DATE 12-28-62 thru 1-4-63

10 X 10 TO THE CM. 359T-14 KEUFFEL & ESSER CO. MADE IN U.S.A. ALBANENE

FIGURE A-33

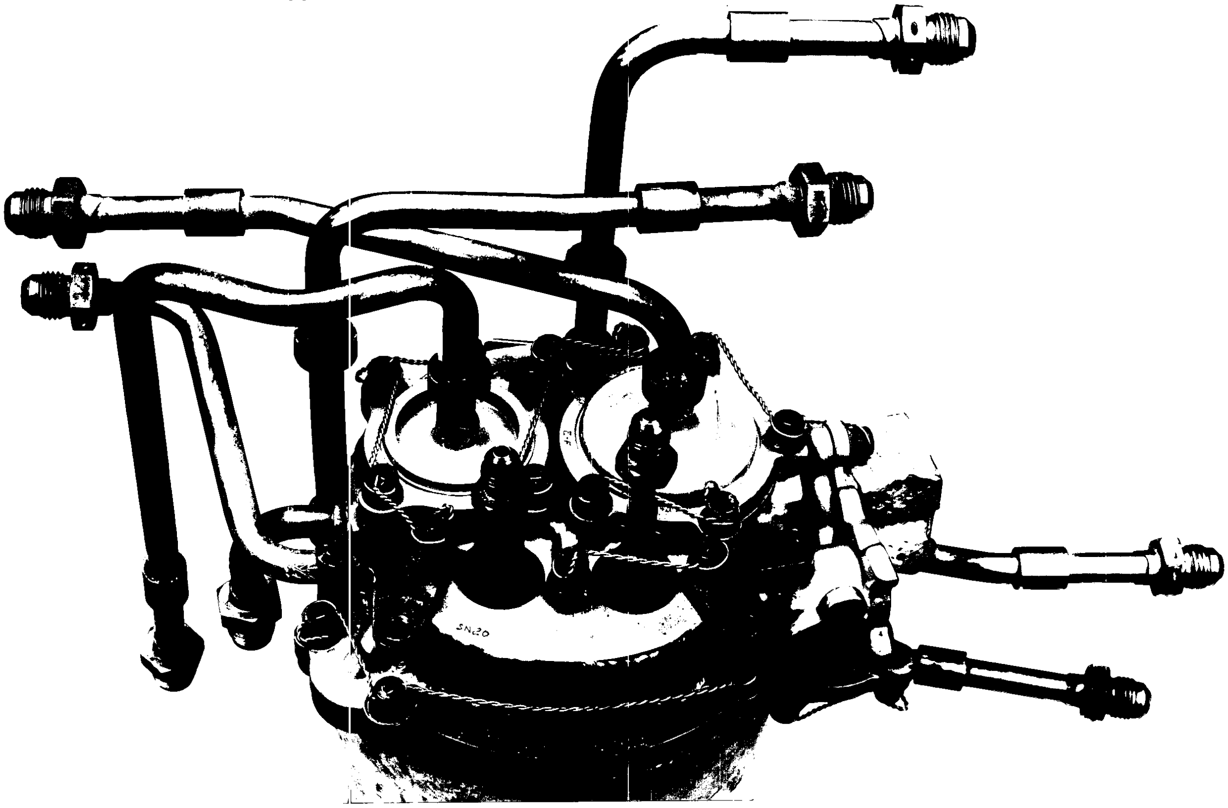


[redacted]

FIGURE A-40

[redacted] CIS 574242L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541 S/N A11A028, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME.

1/14/63 FX-116 FE 30482



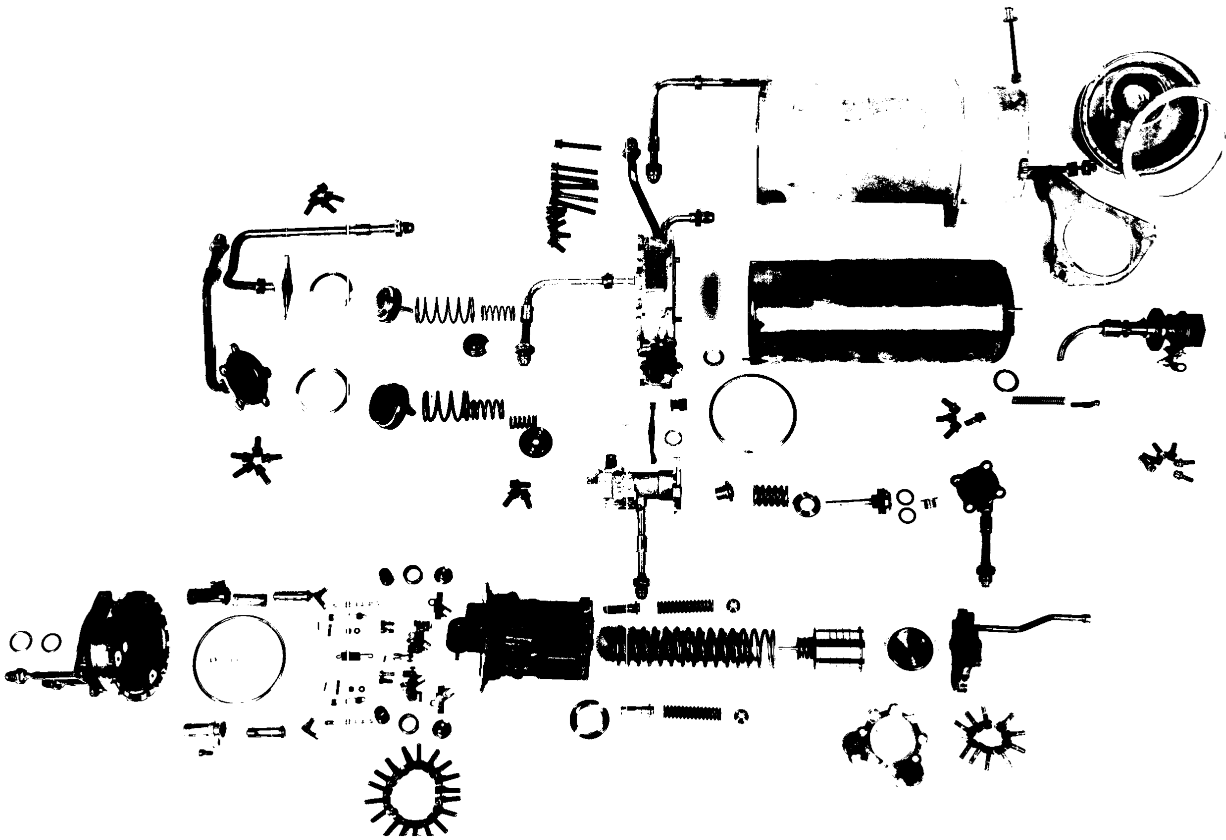
25X1
25X1
25X1

[redacted]

FIGURE A-41

[redacted] 574242L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541 S/N A11A028, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME.

1/14/63 FX-116 FE 30485



25X1
25X1

[redacted]

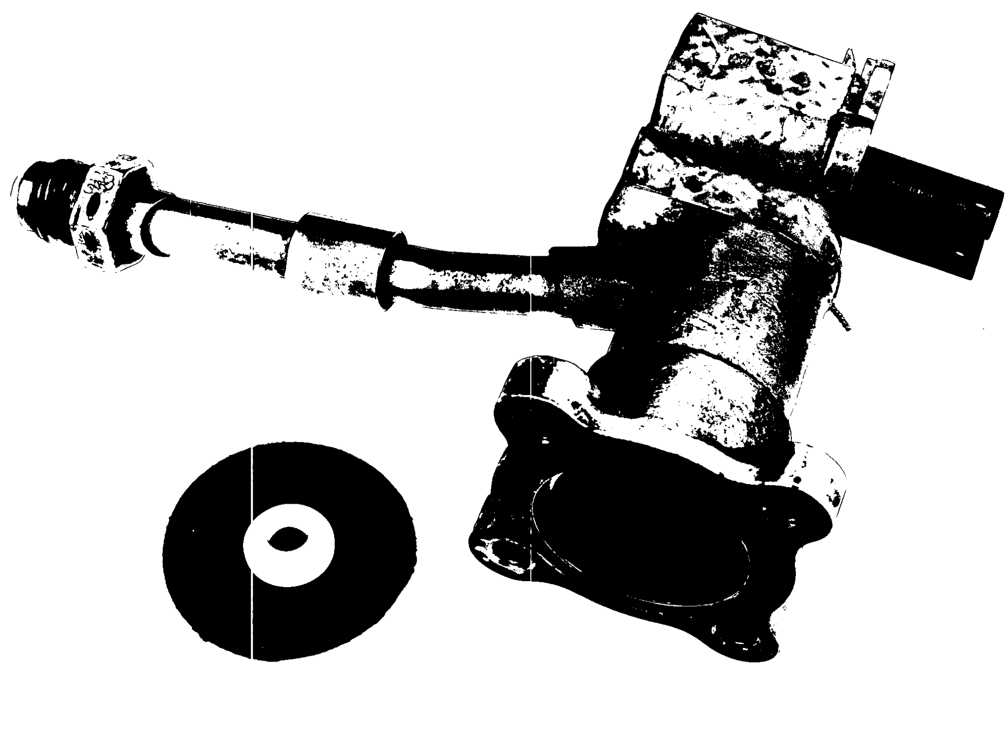
FIGURE A-42

[redacted].I.S. 574242 L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541 S/N A11A028, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 5.25 HOURS TOTAL BENCH TIME, 76.06 HOURS TOTAL ENGINE TIME.

25X1

1/18/63 FX-116 FE 30750

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9



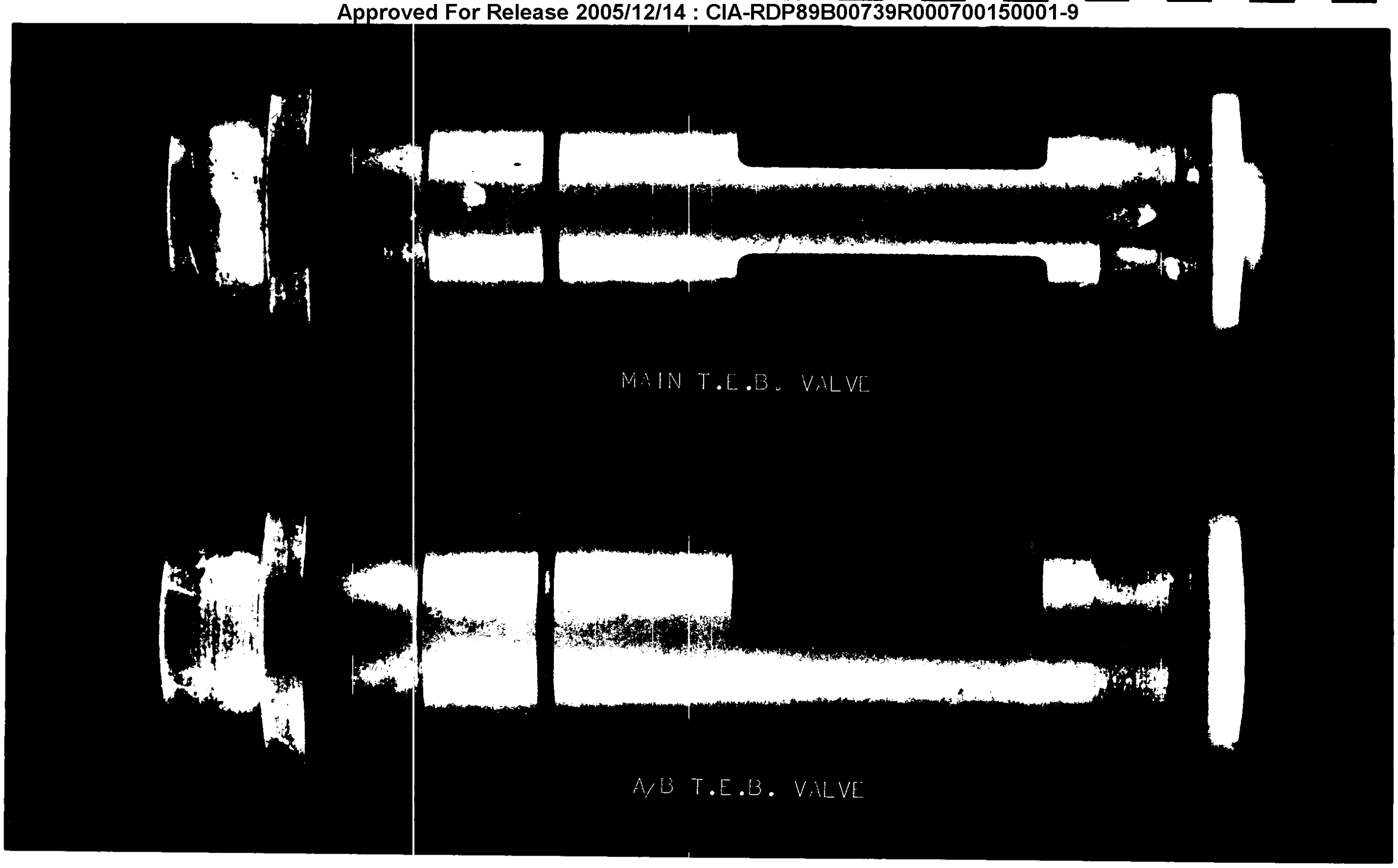
25X1
25X1
[redacted]

FIGURE A-43

[redacted] CIS 574242L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541, S/N A11A028 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING DUMP HOUSING AND TEFLON SEAL. 5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME.

25X1

1/15/63 FX-116 FE 30808



25X1
25X1
[redacted]

FIGURE A-44 APPROXIMATELY 6X MAGNIFICATION

[redacted] CIS 574242L12 CHEMICAL IGNITION CONTROL, [redacted] P/N 205454 S/N A11A028, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING MAIN AND A/B T.E.B. VALVES. 5.25 HOURS TOTAL BENCH TIME, 76.06 HOURS TOTAL ENGINE TIME. 25X1

1/24/63 FX-116 FE 30815

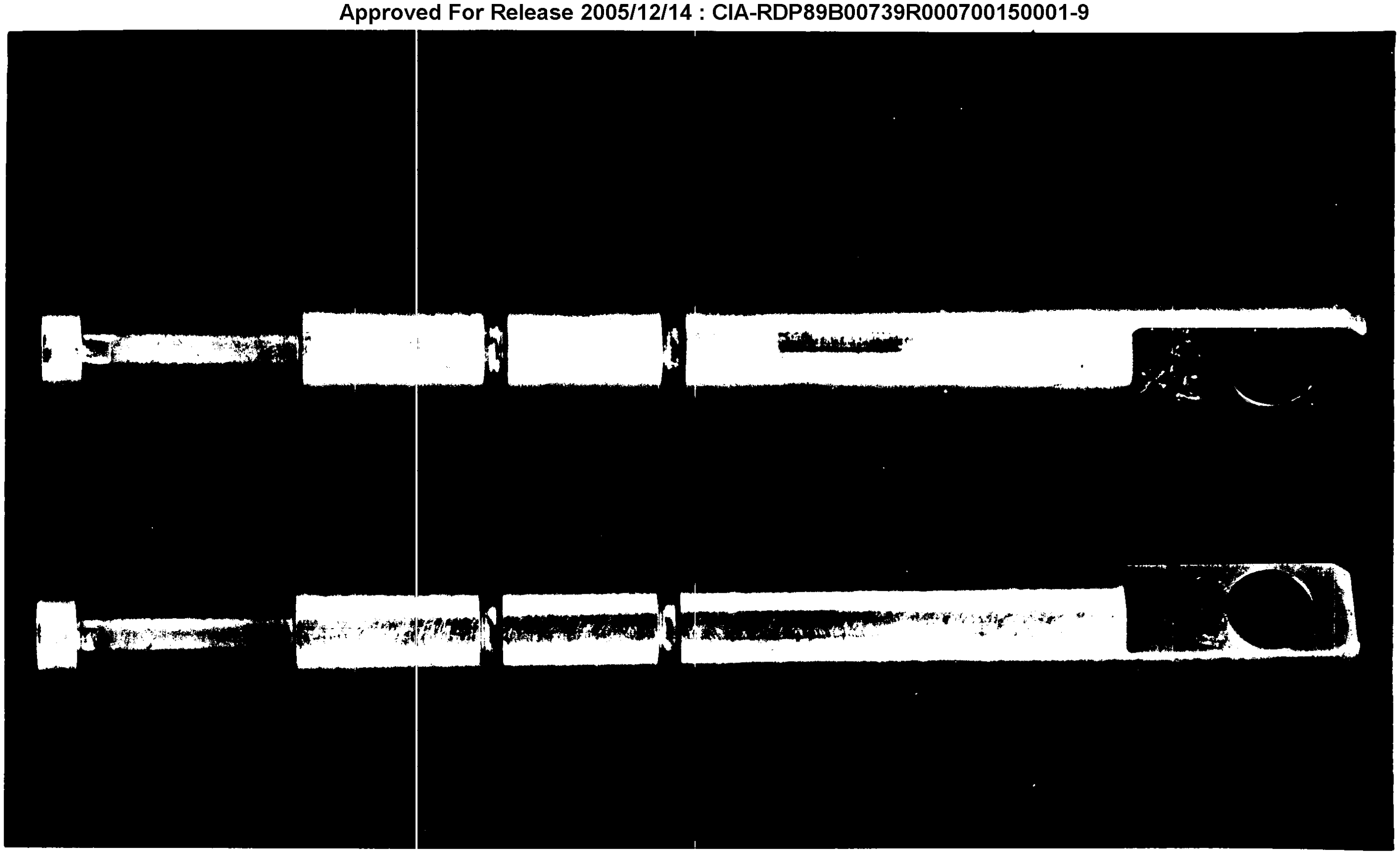
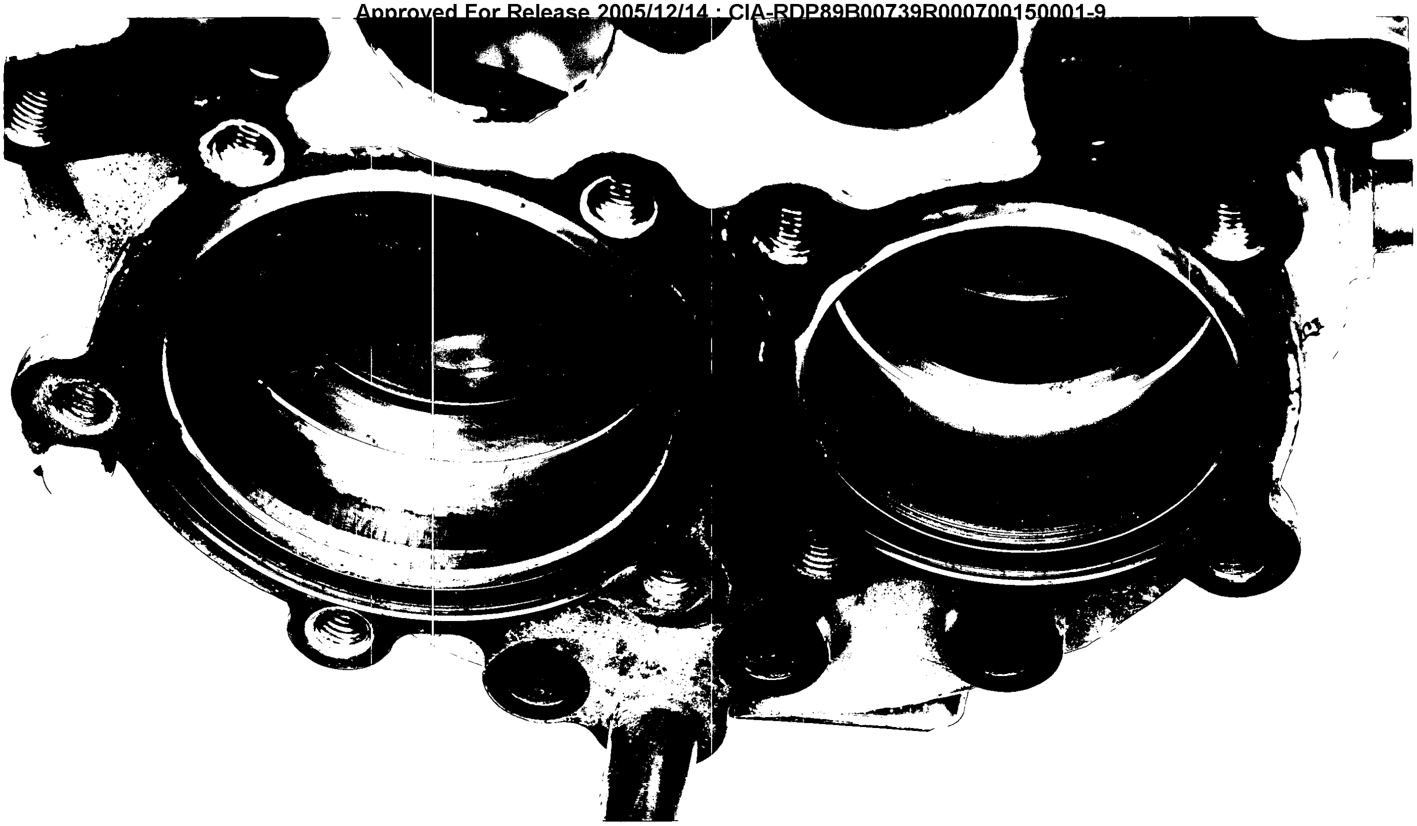


FIGURE A-45 APPROXIMATELY 5X MAGNIFICATION

25X1
25X1

[redacted] C.I.S. 574242 L12 CHEMICAL IGNITION CONTROL, [redacted] 25X1
[redacted], AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A
ENGINE FX-116 SHOWING MAIN AND A/B POPPET STEMS. 5.25 HOURS TOTAL
BENCH TIME, 76.06 HOURS TOTAL ENGINE TIME.

1/15/63 FX-116 FE 30816



25X1

25X1 [redacted]

FIGURE A-46 APPROXIMATELY 2X MAGNIFICATION

[redacted] CIS 574242L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541, S/N A11A028 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING SENSE PISTON BORES. 5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME. 25X1

1/15/63 FX-116 FE 30807

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9

25X1

FIGURE A-47 APPROXIMATELY 3X MAGNIFICATION

25X1 25X1 [redacted] CIS 574242L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541 S/N A11A028, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING MAIN SENSE PISTON. 5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME.

[redacted]

1/15/63 FX-116 FE 30813

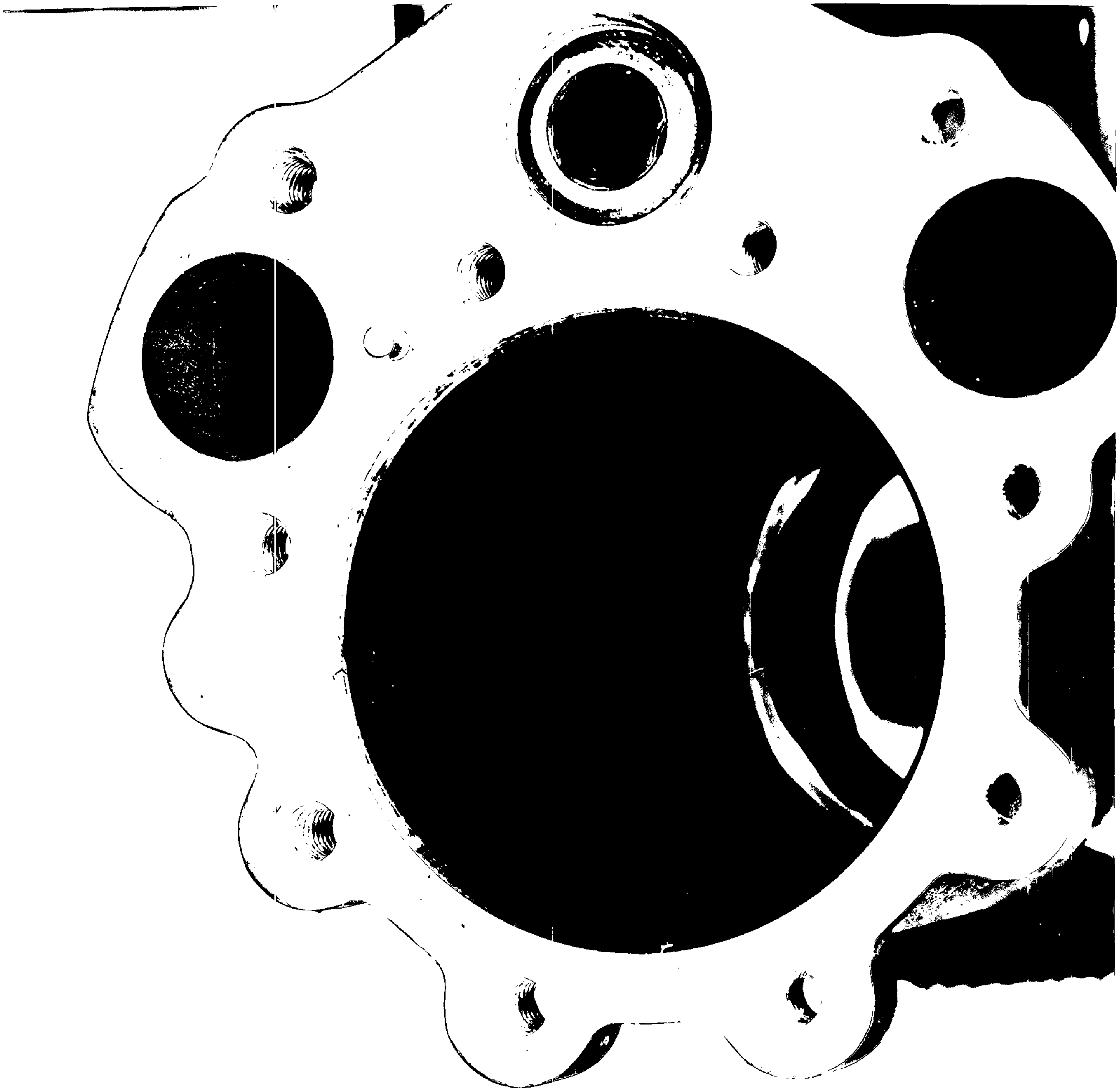
25X1

[redacted]

FIGURE A-48 APPROXIMATELY 2X MAGNIFICATION

25X1 [redacted] CIS 574242L12 CHEMICAL IGNITION CONTROL,
25X1 [redacted] 2051541 S/N A11A028, AFTER FLIGHT SUITABILITY TEST
ON YJT11D-20A ENGINE FX-116 SHOWING METERING PISTON.
5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME.

1/15/63 FX-116 FE 30814



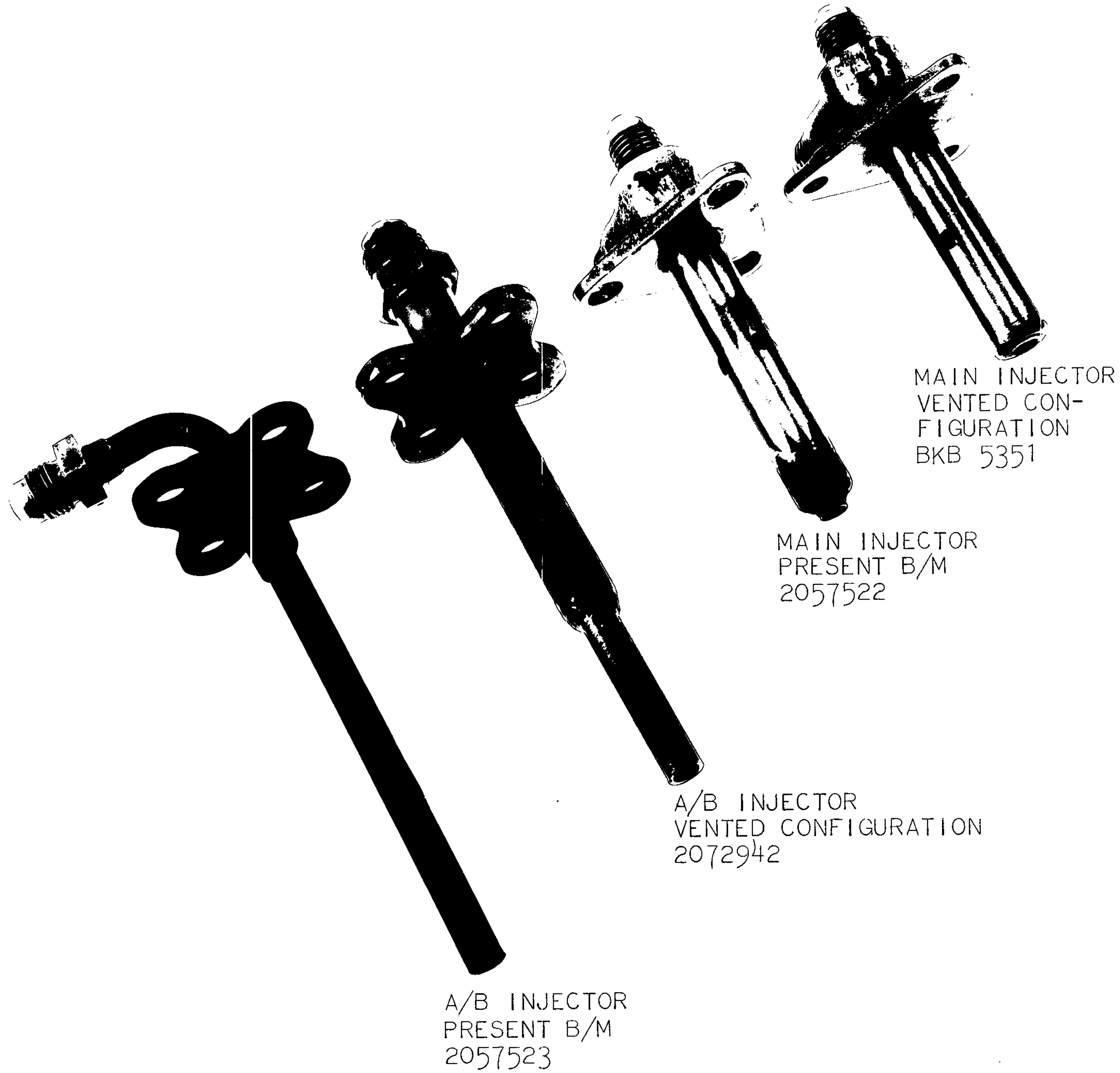
25X1

FIGURE A-49 APPROXIMATELY 2X MAGNIFICATION

25X1
25X1

[redacted] C.I.S. 574242L12 CHEMICAL IGNITION CONTROL, [redacted] 2051541 S/N A11A028, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING METERING PISTON BORE. 5.25 HOURS TOTAL BENCH TIME. 76.06 HOURS TOTAL ENGINE TIME.

1/15/63 FX-116 FE 30806



25X1

FIGURE A-50

MAIN BURNER AND AFTERBURNER T.E.B. INJECTORS SHOWING COMPARISON BETWEEN PRESENT BILL OF MATERIAL AND NEW VENTED CONFIGURATION.

1/25/63 FX-116 FE 30918

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9

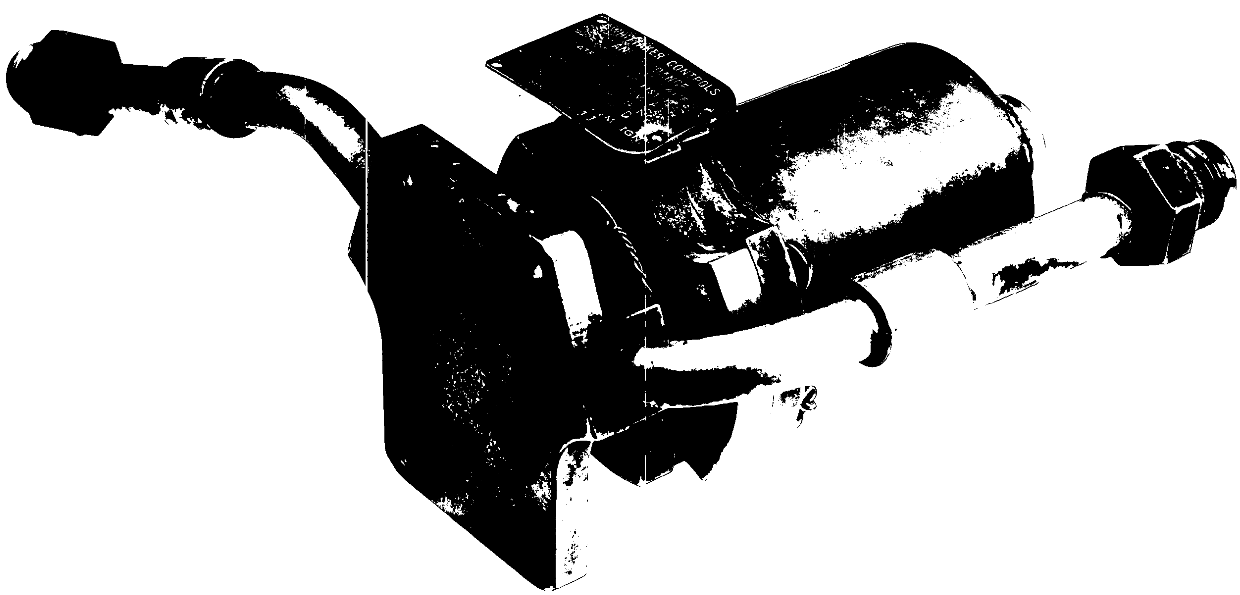


FIGURE A-51

25X1
25X1
25X1

[redacted]

[redacted] 135995 PL REV C CHEMICAL IGNITION DUMP SOLENOID, [redacted] 2046483 S/N A65A029, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 3.49 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/14/63 FX-116 FE 30475

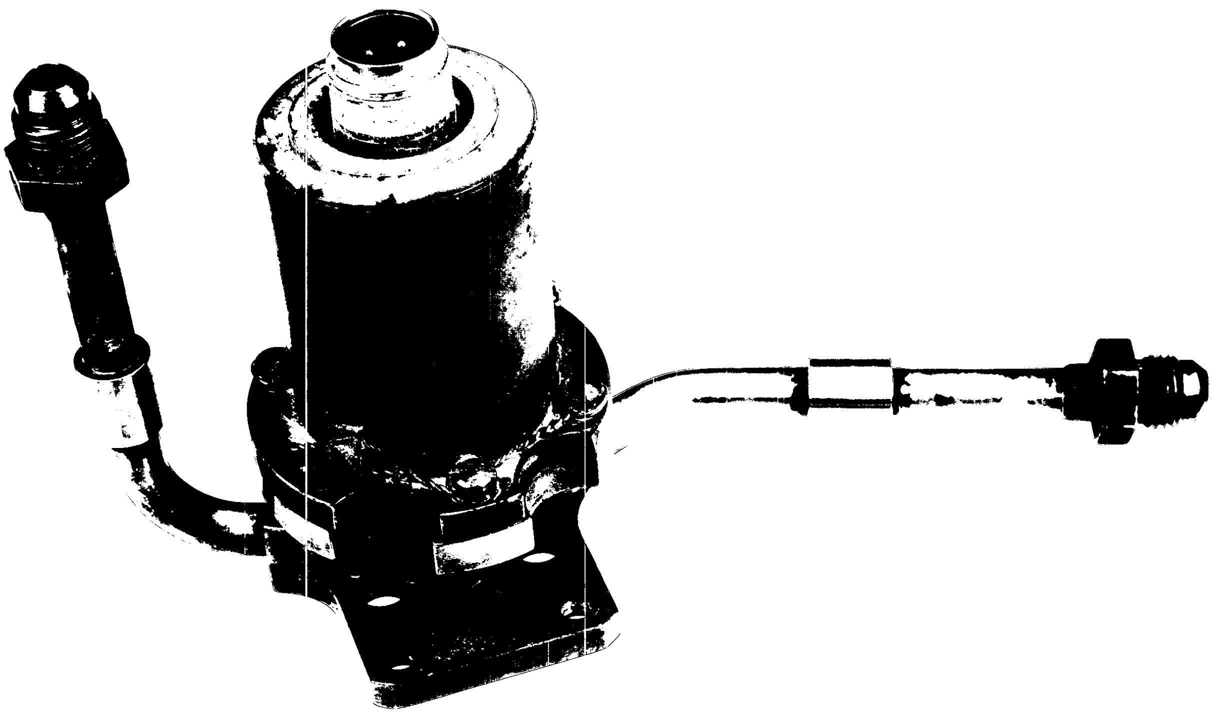
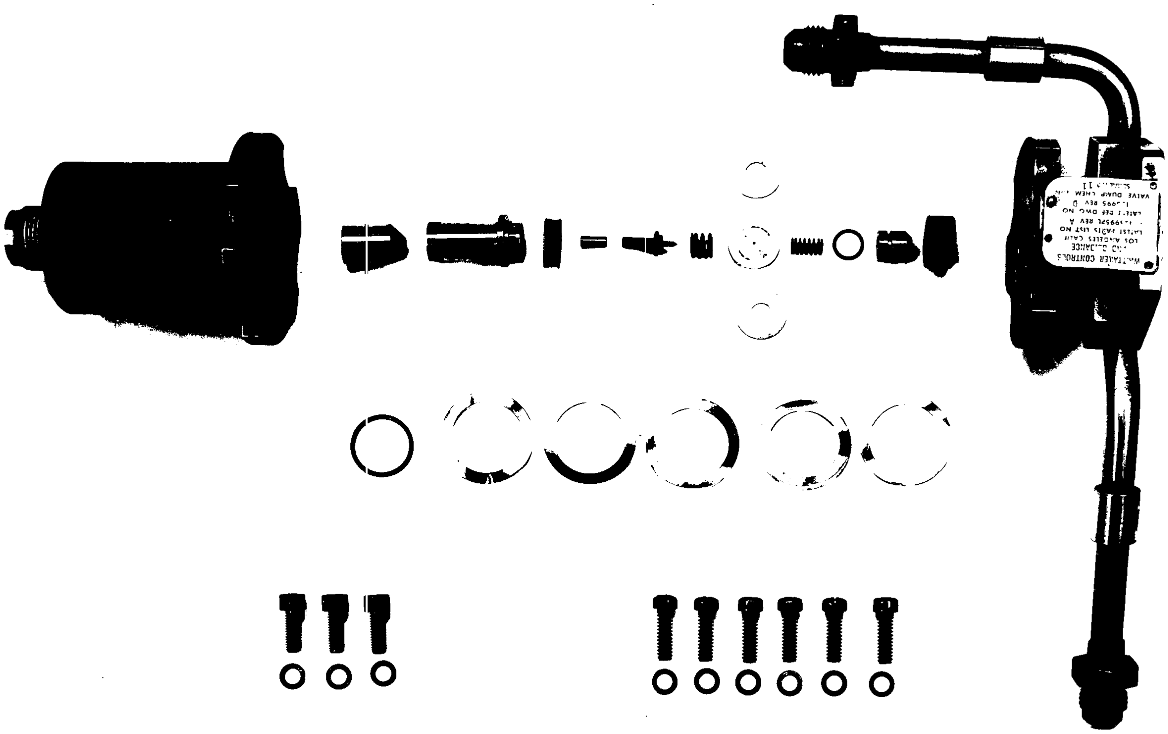


FIGURE A-52

25X1
25X1
25X1

[redacted] 135995 PL REV C CHEMICAL IGNITION DUMP SOLENOID VALVE, [redacted] 2046483 S/N A65A029, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 3.49 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 30476

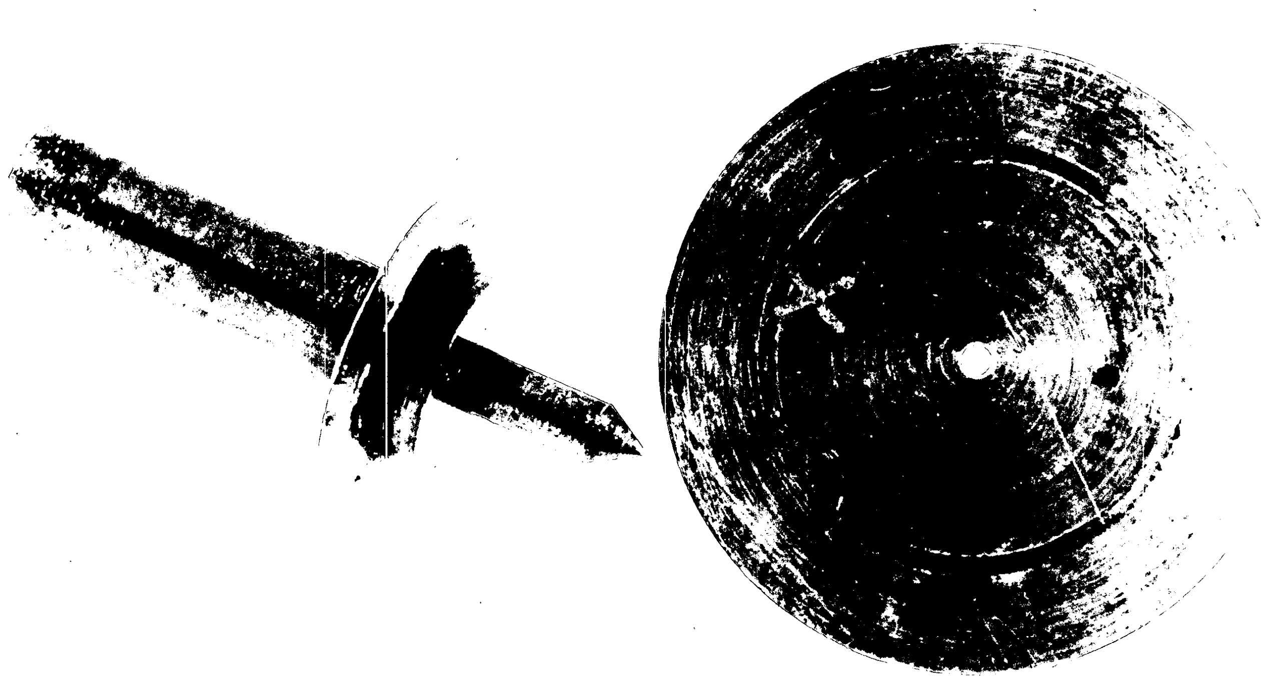


25X1 [redacted]

FIGURE A-53

25X1 [redacted] 135995 PL REVC CHEMICAL IGNITION DUMP SOLENOID, [redacted] 2046483 SN A65A029, AFTER FLIGHT SUITABILITY TEST ON YJT11D-20 ENGINE FX116. 3.49 HRS. TOTAL BENCH TIME, 97.35 HRS. TOTAL ENGINE TIME. 25X1

1/21/63 FX-116 FE 30774



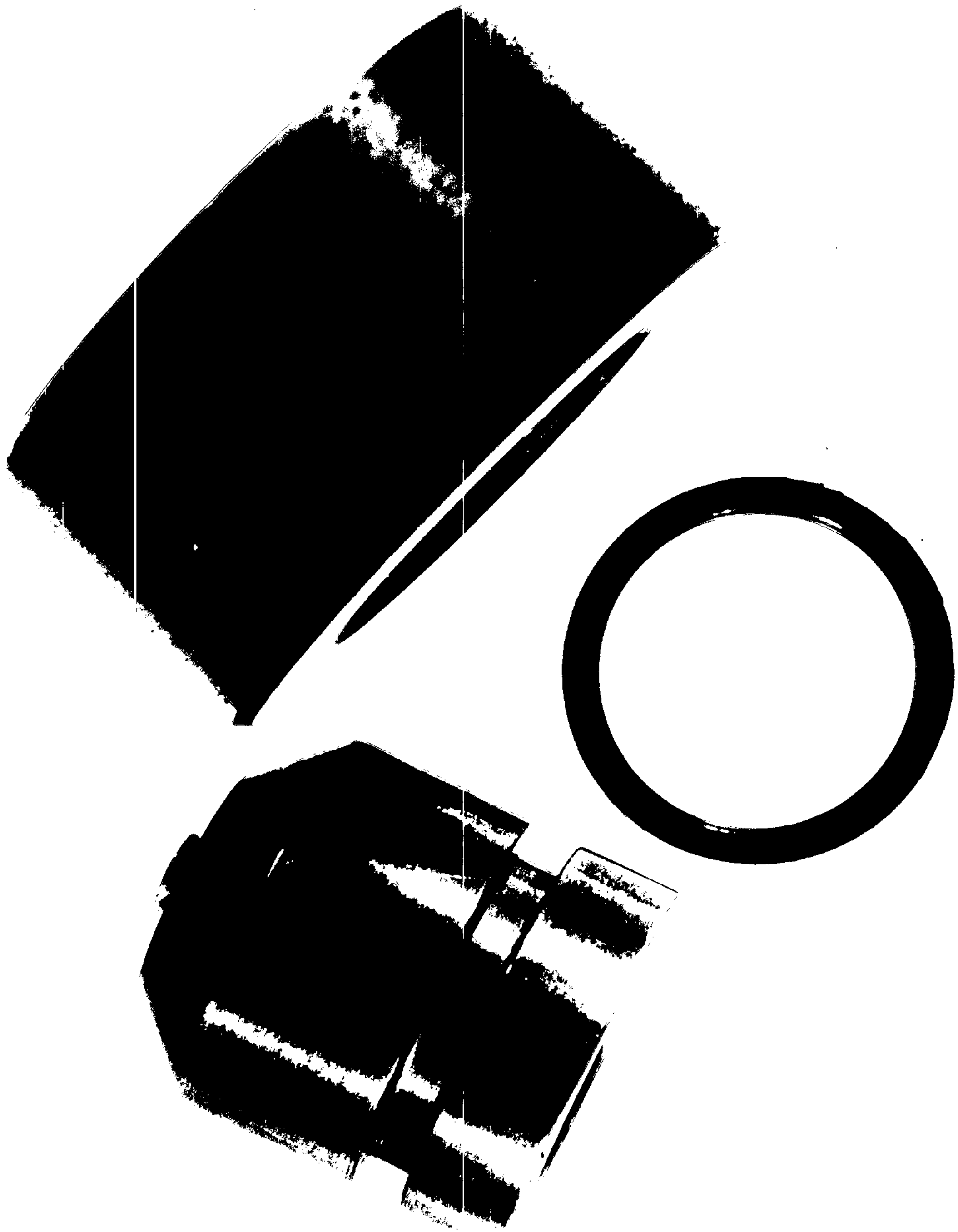
25X1
25X1
25X1

[redacted]

FIGURE A-54 APPROXIMATELY 3.5X MAGNIFICATION

[redacted] 135995 PL REV C CHEMICAL IGNITION DUMP SOLENOID VALVE, [redacted] 2046483, S/N A65A029 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116, SHOWING SOLENOID VALVE AND ORIFICE PLATE. 3.49 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 31231



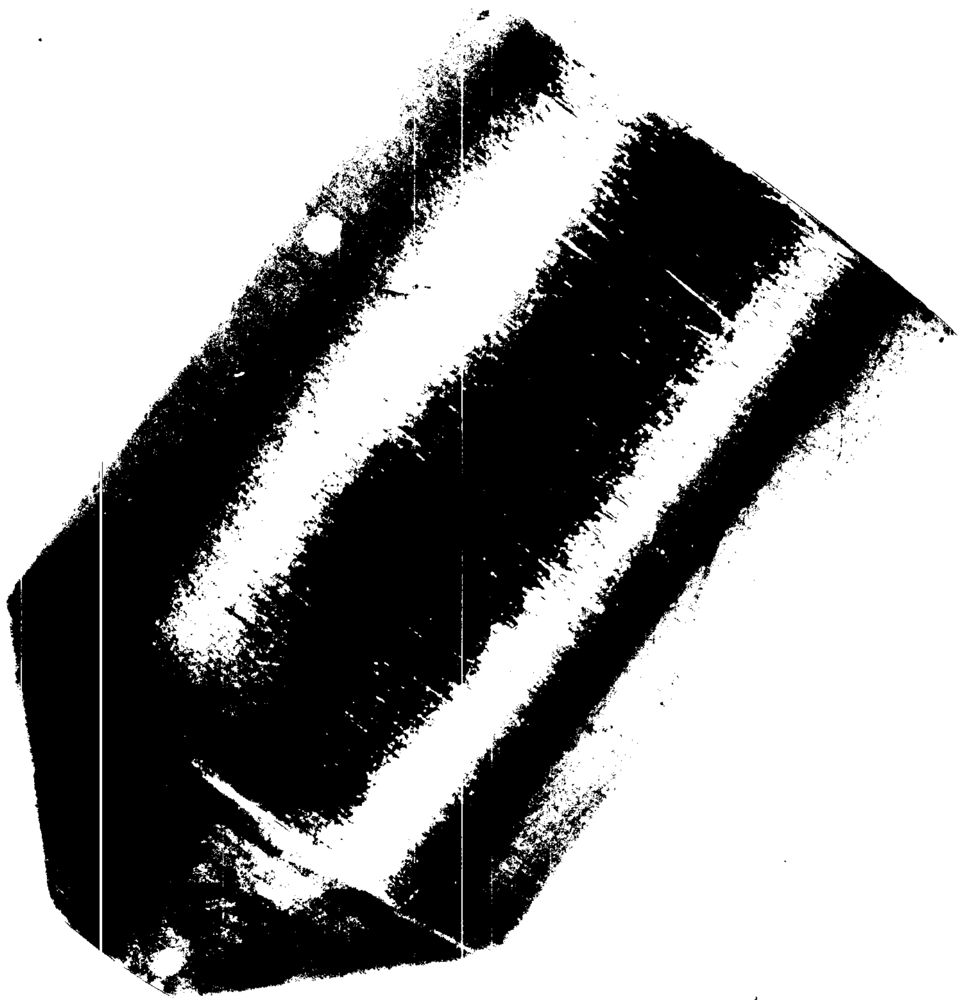
25X1 [redacted]

25X1

FIGURE A-55 APPROXIMATELY 3.5X MAGNIFICATION

[redacted] 135995 PL REV C CHEMICAL IGNITION DUMP SOLENOID VALVE, [redacted] 2046483, S/N A65A029 25X1 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116, SHOWING POPPET VALVE AND BUSHING. 3.49 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

1/31/63 FX-116 FE 31232



25X1

25X1

[redacted]

FIGURE A-56 APPROXIMATELY 3X MAGNIFICATION

[redacted] 135995 PL REV C CHEMICAL IGNITION DUMP SOLENOID VALVE, [redacted] 2046483, S/N A65A029 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116, SHOWING SOLENOID PLUNGER. 3.49 HOURS TOTAL BENCH TIME, 97.35 HOURS TOTAL ENGINE TIME.

25X1

1/31/63 FX-116 FE 31233

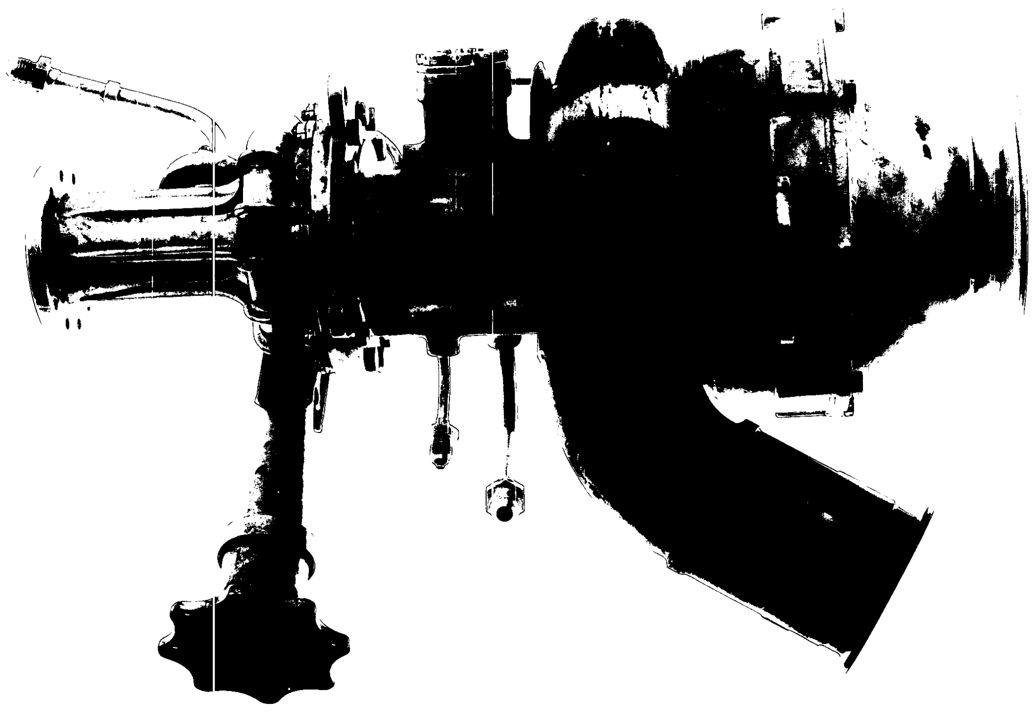


FIGURE A-57

25X1
25X1
25X1

[redacted]

[redacted] TP C6 580395 LI A/B TURBO PUMP, [redacted] 2067189 SERIAL NO. A02A020 AFTER FLIGHT SUIT-ABILITY TEST ON YJT11D-20A ENGINE FX-116. 21.92 HOURS TOTAL BENCH TIME , 158.94 HOURS ENGINE TIME.

1/30/63 FX-116 FE 30960

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9

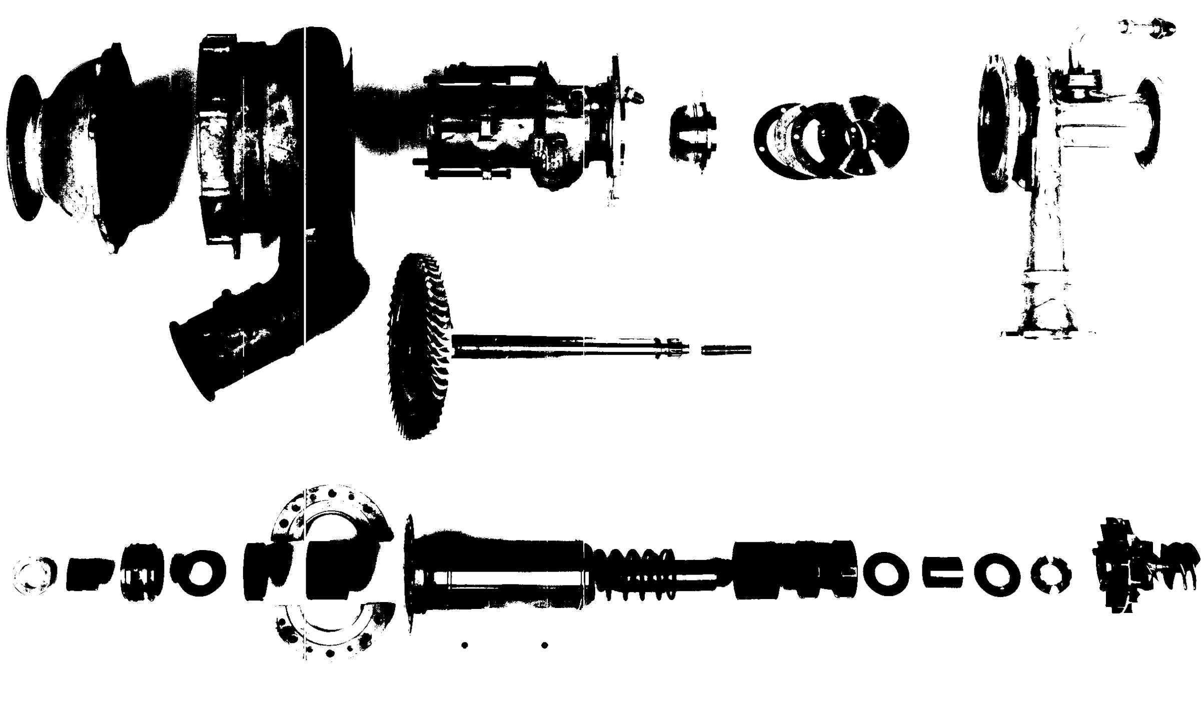


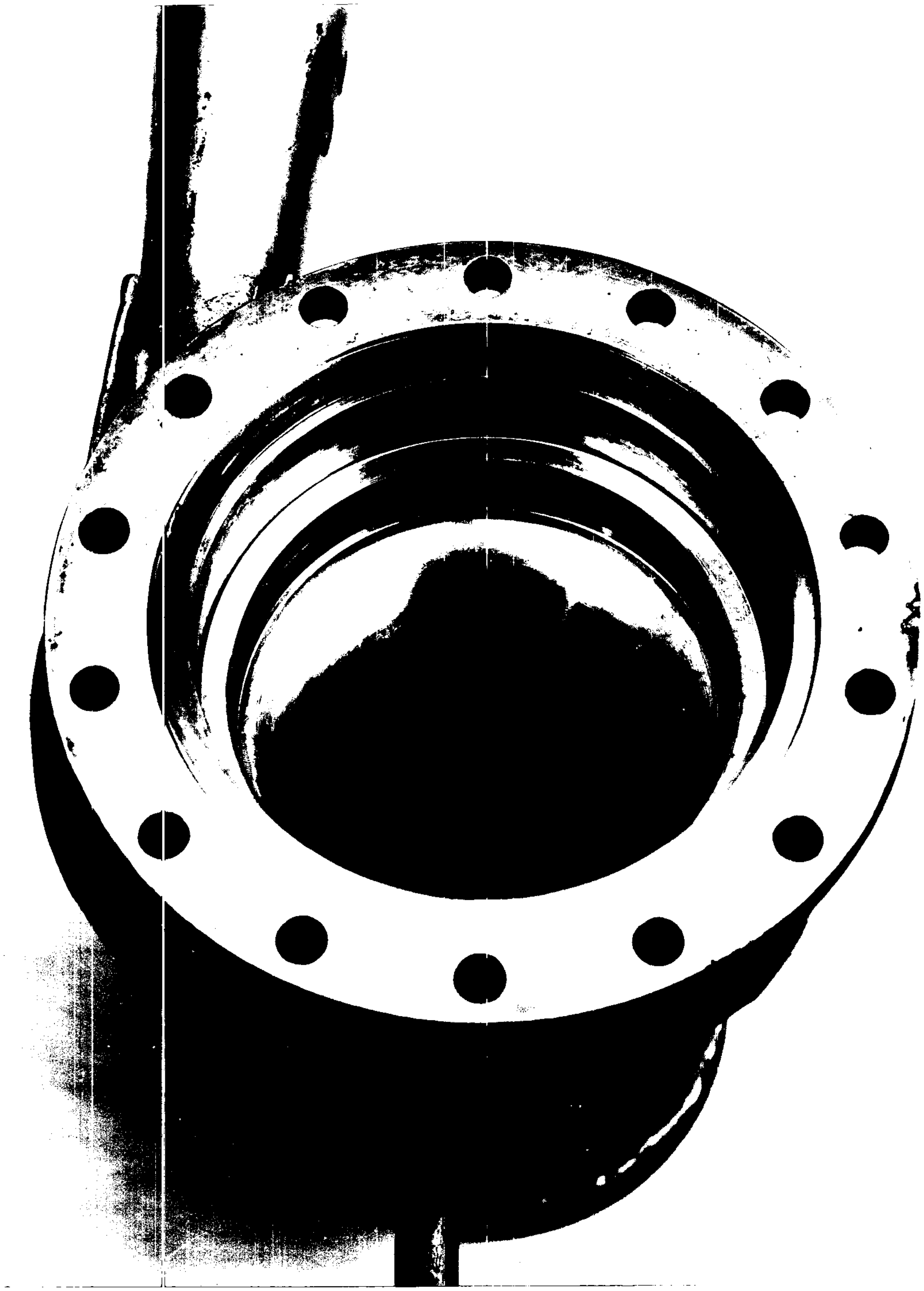
FIGURE A-58

25X1
25X1
25X1

[redacted]

[redacted] TP-C6 580395 LI A/B TURBO PUMP, [redacted] 206/189 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30872

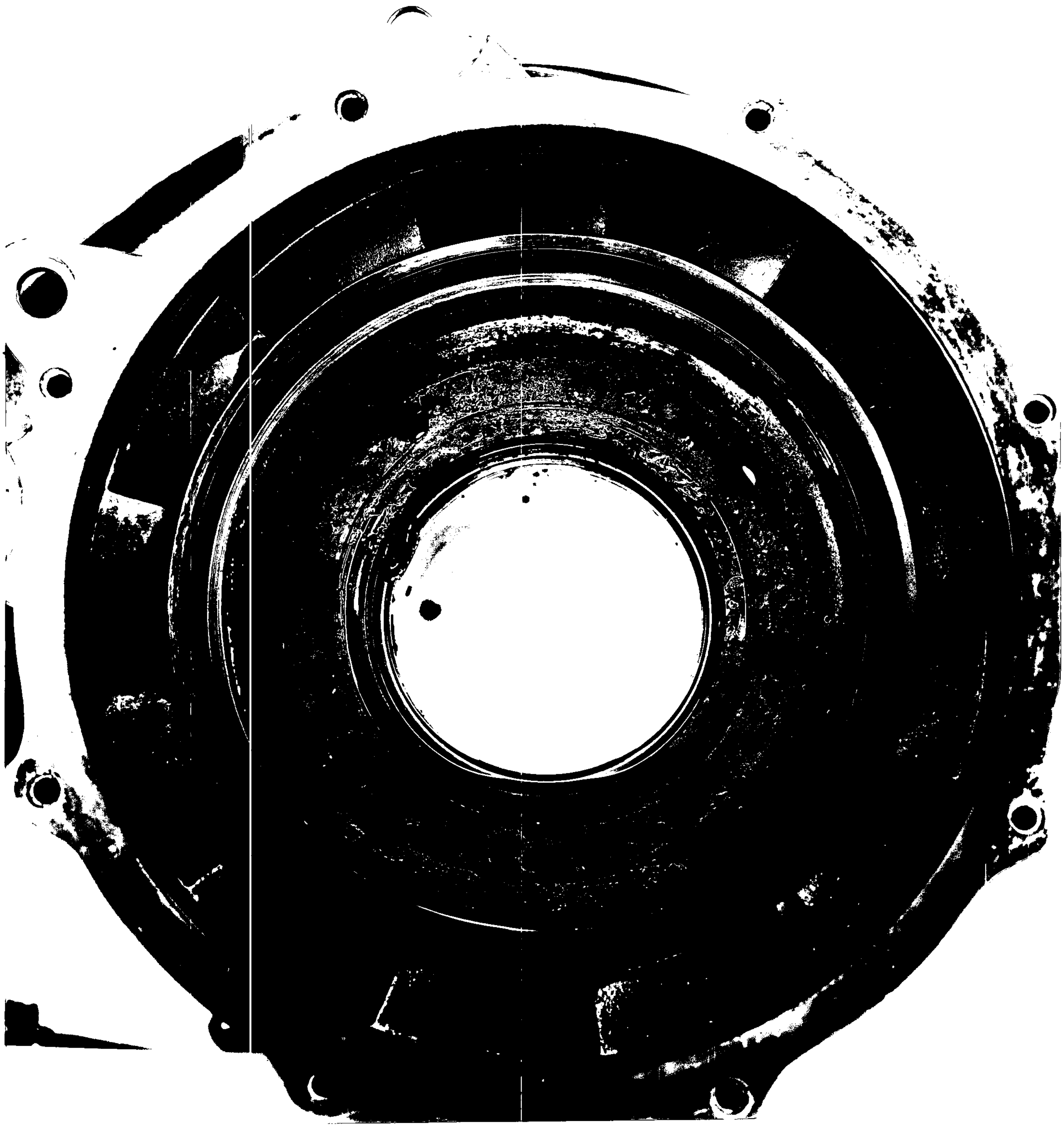


25X1
25X1
25X1

FIGURE A-59

[redacted] TP-C6 580395 LI A/B TURBO PUMP, [redacted] 2067169 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING IMPELLER HOUSING, 21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30579



25X1

25X1

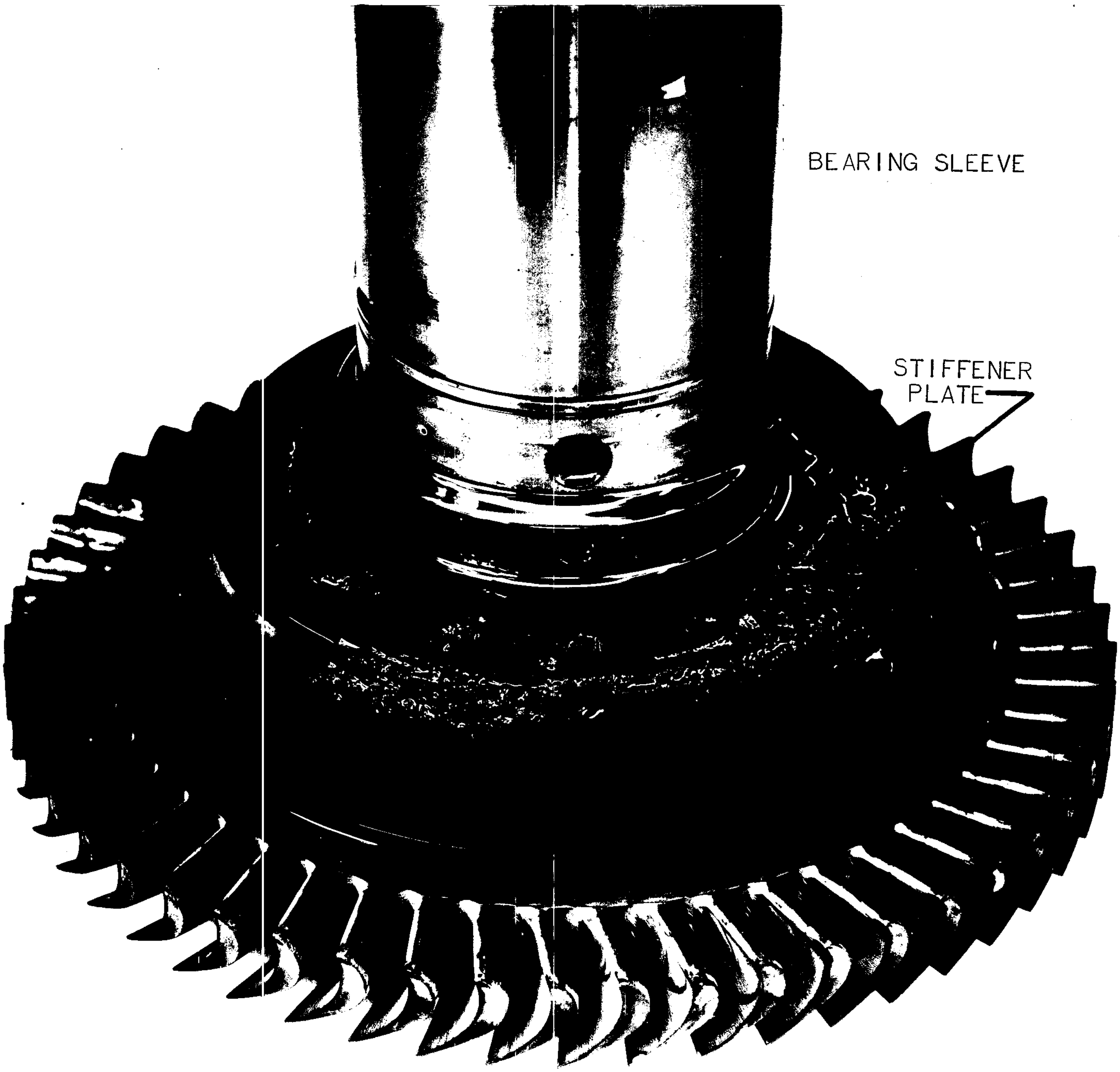
25X1

[redacted]

FIGURE A-60

[redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 2067189 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING AFT SECTION OF THE TURBINE HOUSING. 21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30509



25X1

[redacted]

FIGURE A-61

25X1 [redacted] TP-C6 580395LI A/B TURBO PUMP, [redacted] 25X1
2C67189 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING BEARING SLEEVE FLANGE, STIFFENER PLATE & TURBINE. 21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30510

25X1

25X1

[redacted]

FIGURE A-62 APPROXIMATELY 2X MAGNIFICATION

[redacted] TP C6 580395LI A/B TURBO PUMP, [redacted] 25X1
2067189 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON
YJT11D-20 ENGINE FX-116 SHOWING THE FRONT CARBON SEAL
OIL SIDE. 18.84 HOURS TOTAL BENCH TIME, 69.55 HOURS
TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30513

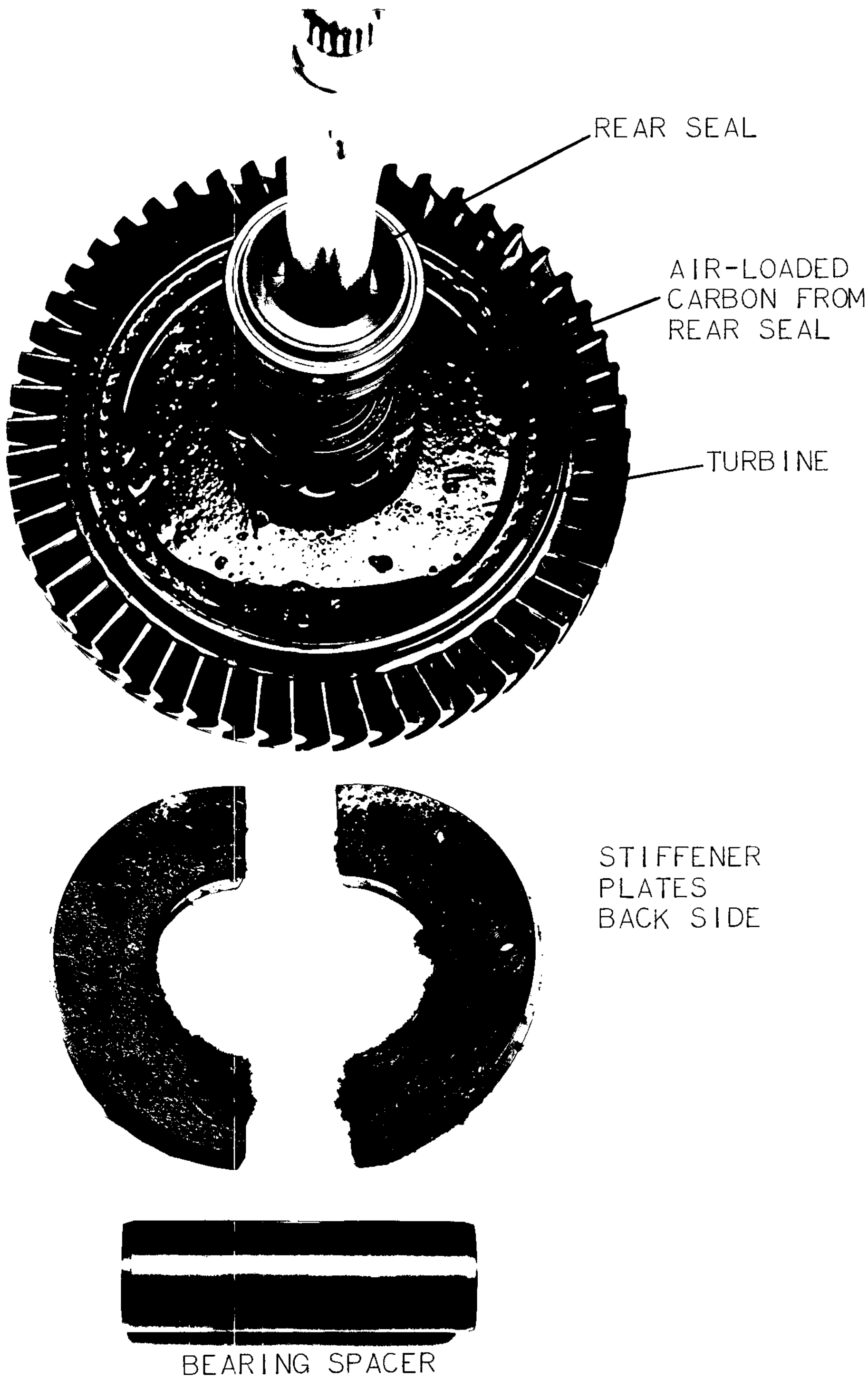


FIGURE A-63

25X1 TP-C6 580395L1 A/B TURBO PUMP, 25X1
2067189, S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING REAR SEAL, TURBINE, STIFFNER PLATE AND BEARING SPACER. 21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS TOTAL ENGINE TIME, EXCEPT 18.84 HOURS TOTAL BENCH TIME AND 69.55 HOURS TOTAL ENGINE TIME ON REAR SEAL.

1/30/63 FX-116 FE 30578

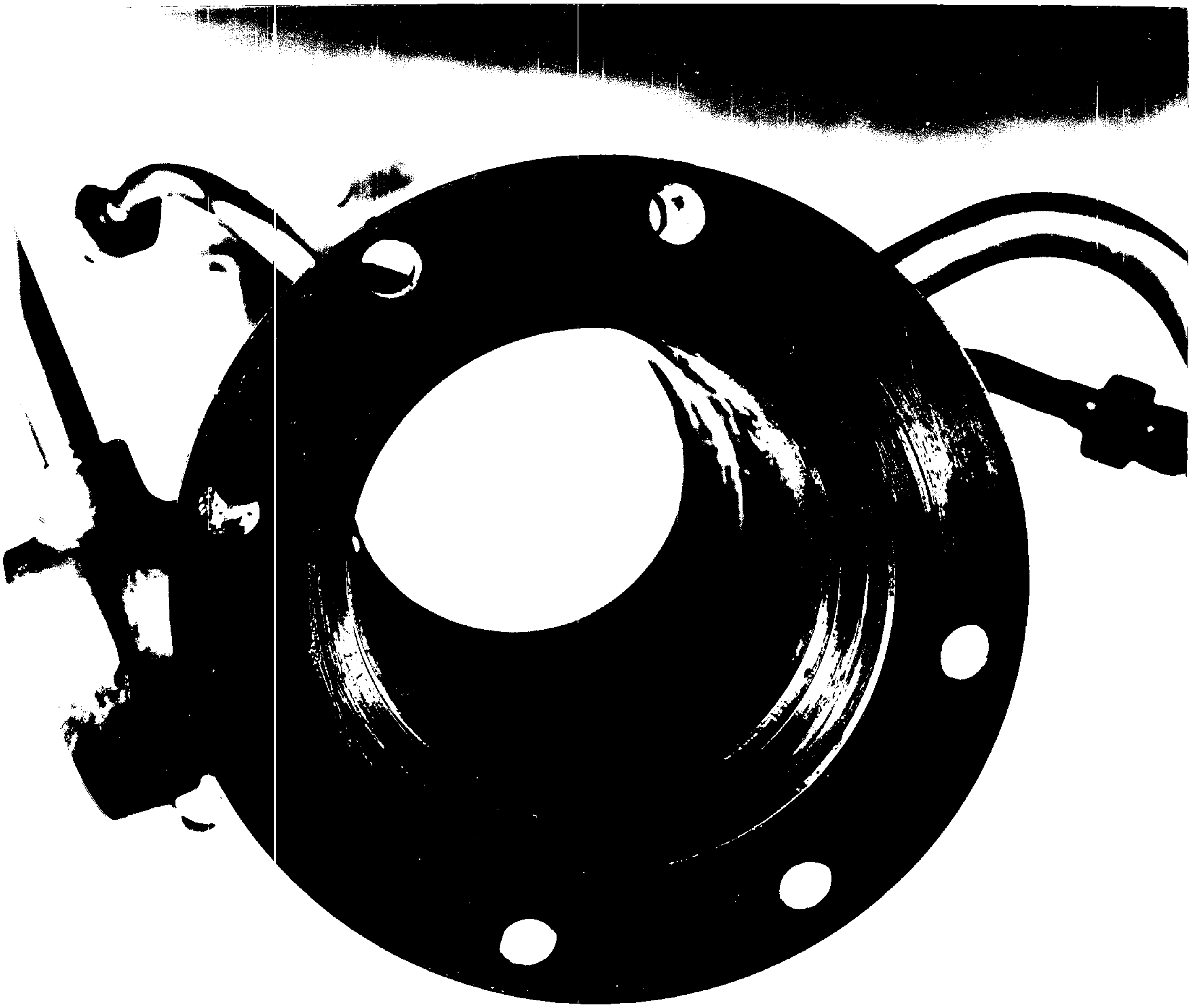
25X1

FIGURE A-64

25X1 [redacted]

[redacted] TP-C6 580395 LI A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON
YJT11D-20A ENGINE FX-116 SHOWING INSIDE OF VENTURI.
21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS TOTAL ENGINE
TIME.

1/30/63 FX-116 FE 30511



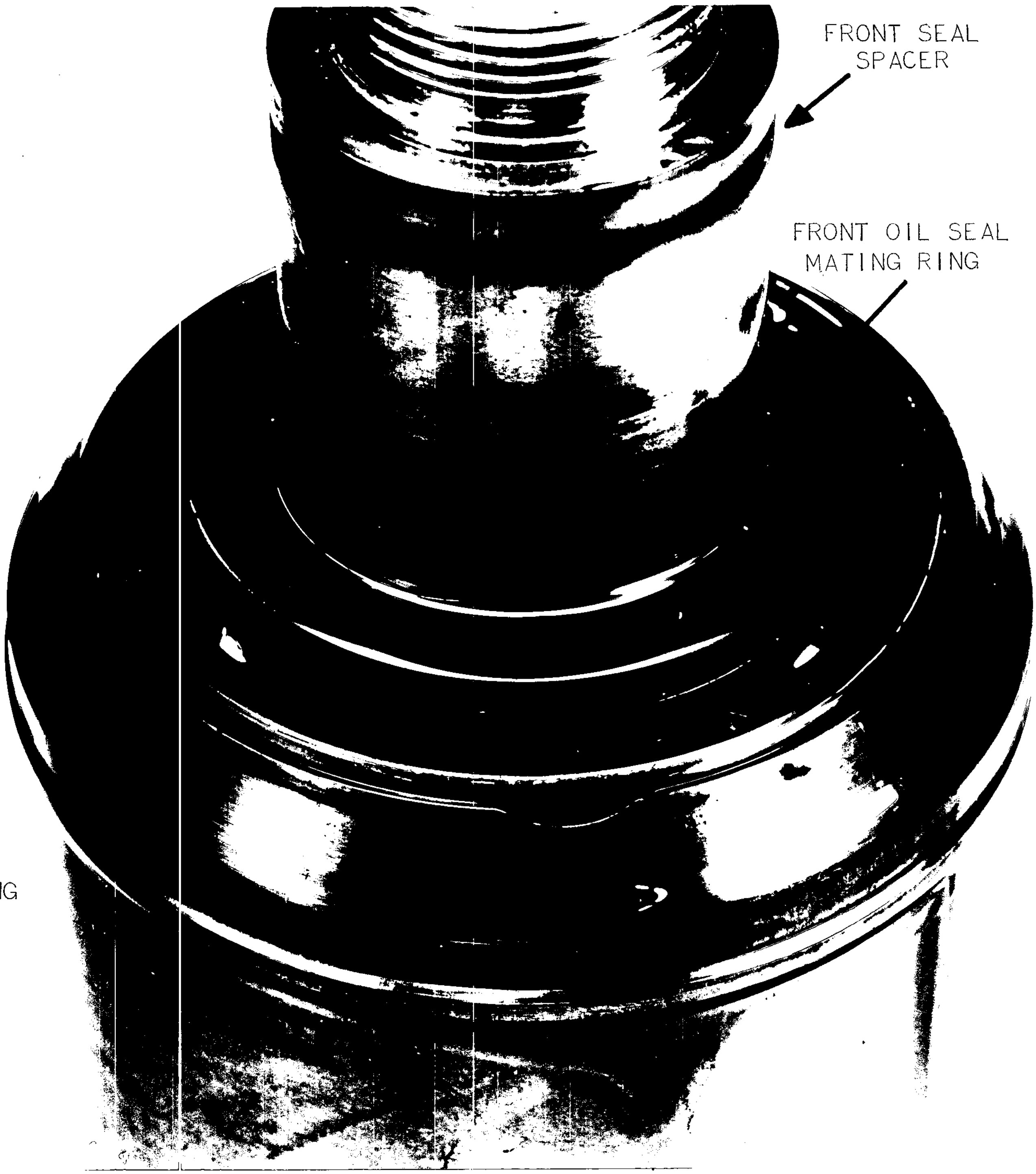
25X1

FIGURE A-65

25X1 [redacted] [redacted] TP-C6 580395 LI A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON
YJT11D-20A ENGINE FX-116 SHOWING KNIFE EDGE SEALS IN
OIL HOUSING. 21.92 HOURS TOTAL BENCH TIME, 158.94 HOURS
TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30709

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9



25X1

[redacted]

FIGURE A-66 APPROXIMATELY 2X MAGNIFICATION

25X1

[redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1
2067189, S/NA02A020 AFTER FLIGHT SUITABILITY TEST ON
YJT11D-20A ENGINE FX-116 SHOWING BEARING SLEEVE, FRONT
OIL SEAL SPACER AND MATING RING. 21.92 HOURS TOTAL
BENCH TIME, 158.94 HOURS TOTAL ENGINE TIME EXCEPT 18.84
HOURS TOTAL BENCH TIME AND 69.55 HOURS TOTAL ENGINE
TIME ON SEAL SPACER AND MATING RING.
1/30/63 FX-116 FE 30512

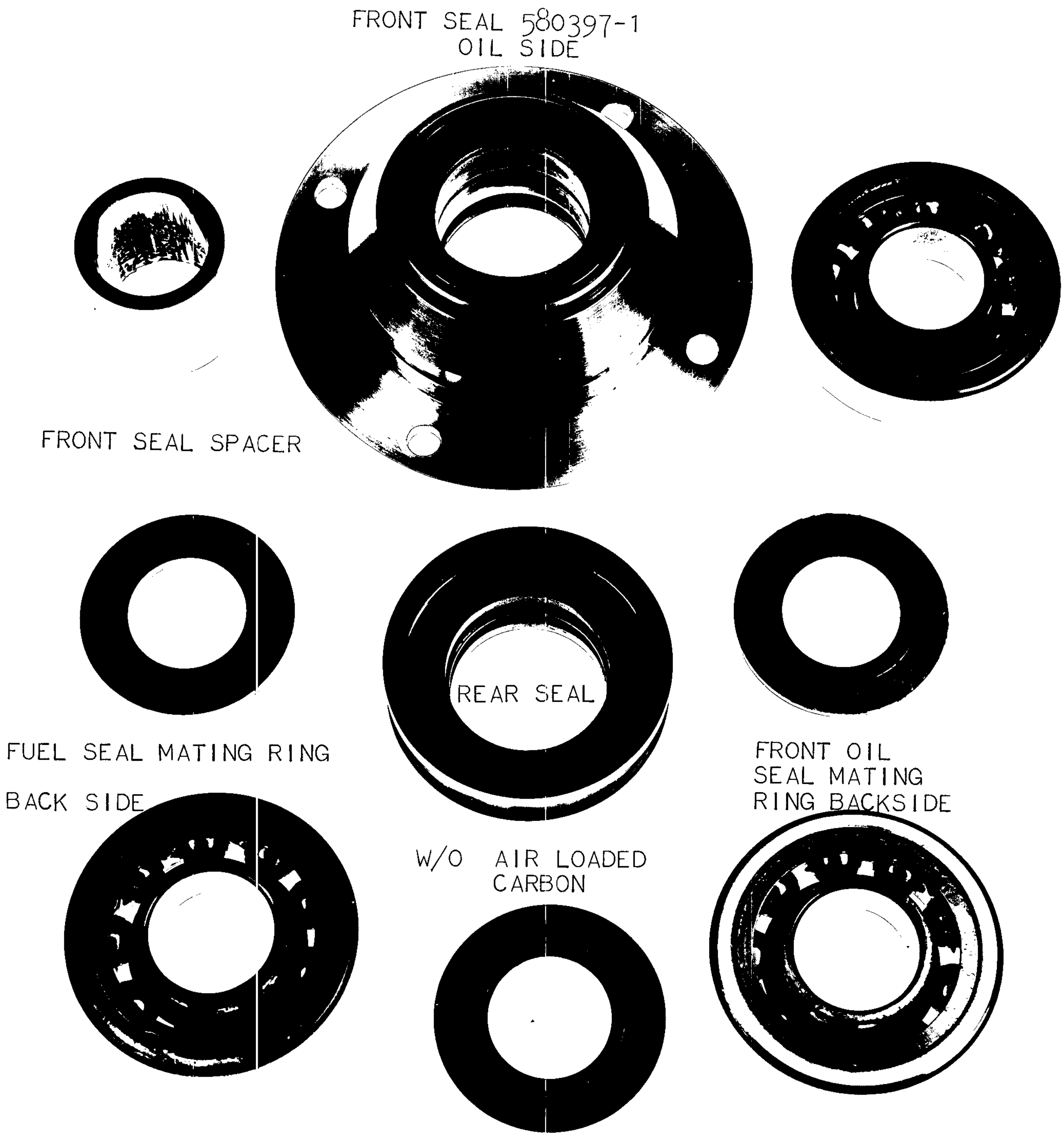


FIGURE A-67

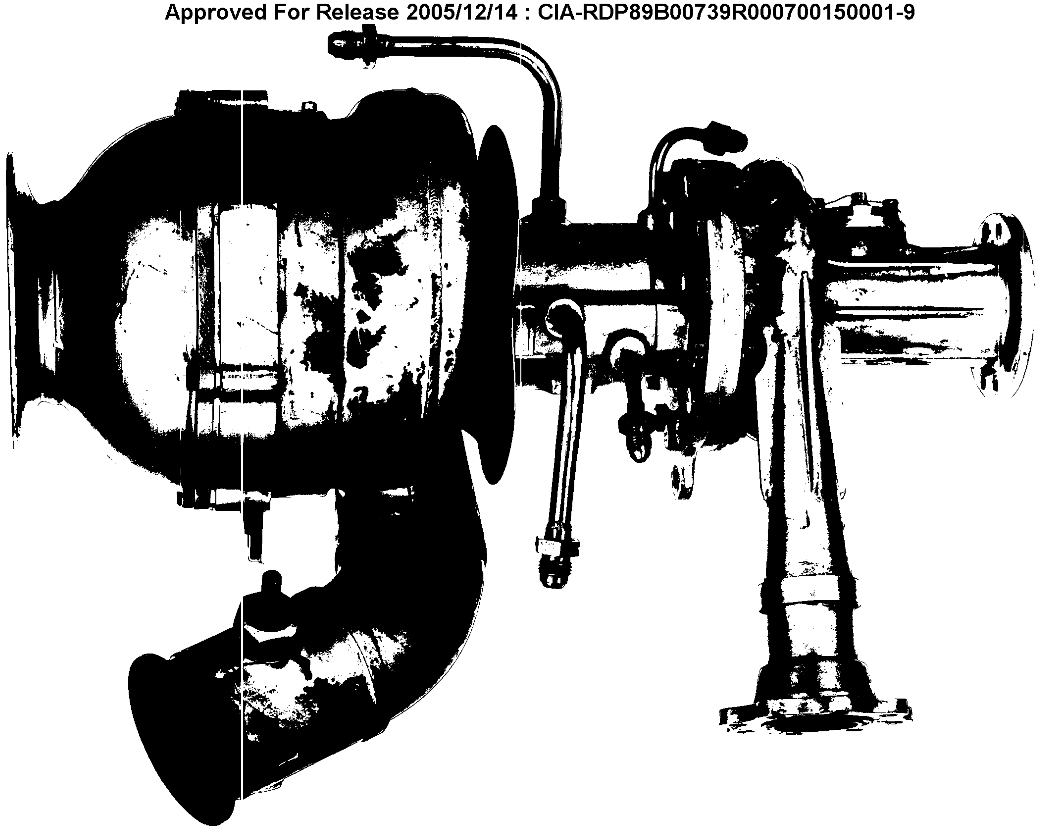
25X1

25X1
25X1

[redacted]

[redacted] TP-C6 580395 LI A/B TURBO PUMP, [redacted] 2067189 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING BEARINGS AND SEALS. 18.84 HOURS TOTAL BENCH TIME, 69.55 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30581



25X1
25X1
25X1

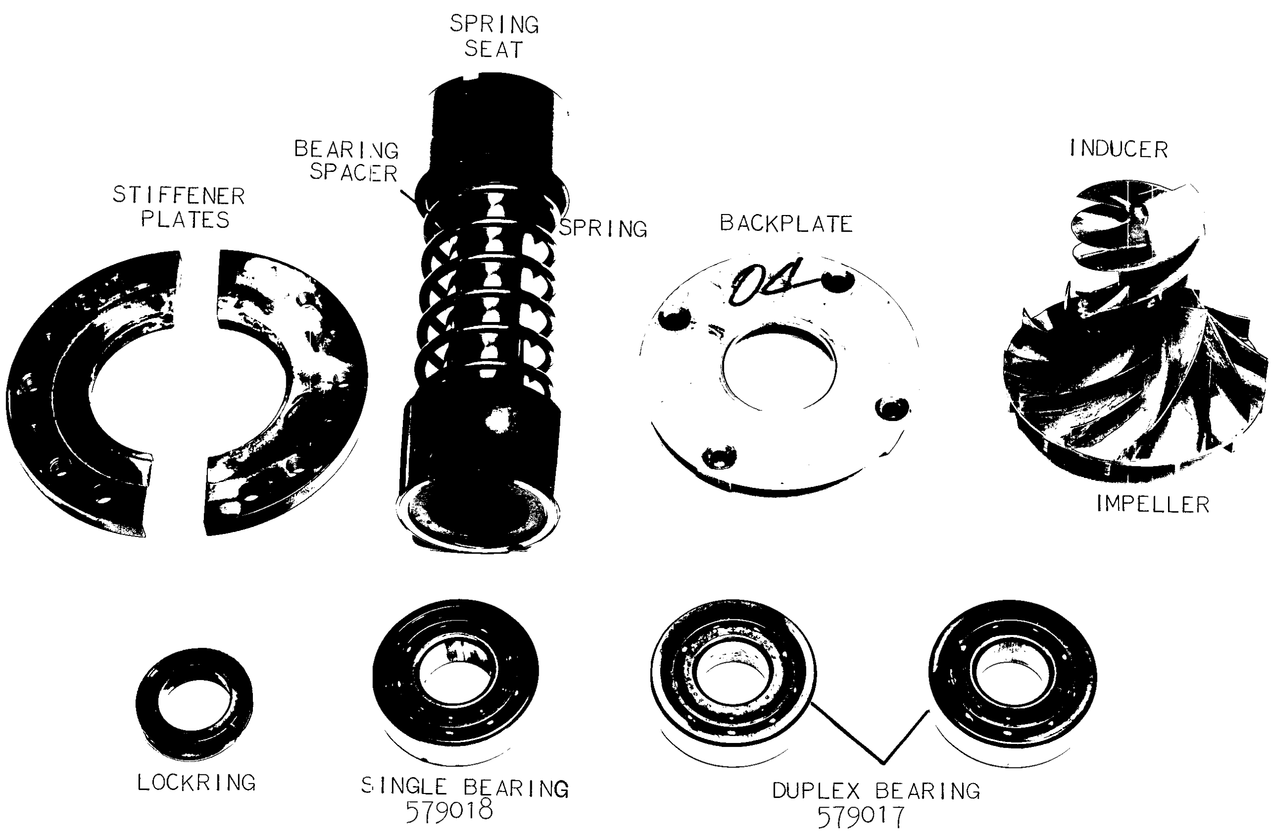
[redacted]

FIGURE A-69

[redacted] TP-C6 580395 LI A/B TURBO PUMP, [redacted] 205/189 SERIAL NO. A02A004 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116. 554.49 HOURS TOTAL BENCH TIME, 198.19 HOURS TOTAL ENGINE TIME.

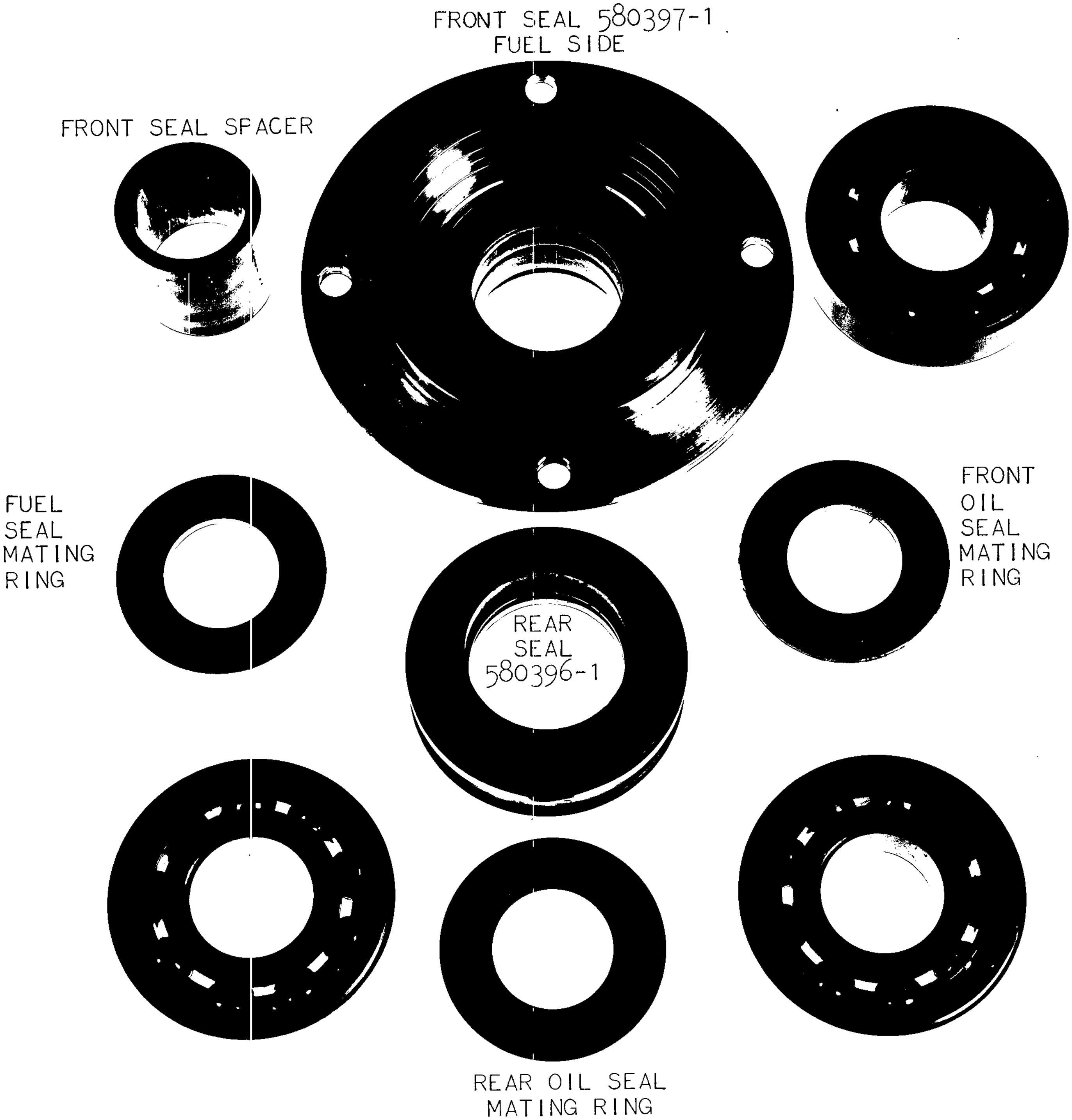
1/30/63 FX-116 FE 31143

Approved For Release 2005/12/14 : CIA-RDP89B00739R000700150001-9



25X1 [redacted] FIGURE A-70

25X1 [redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A02A004 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX116 SHOWING PARTS. 554.49 HOURS TOTAL BENCH TIME, 198.19 HOURS TOTAL ENGINE TIME, EXCEPT 3.24 HOURS TOTAL BENCH TIME AND 28.65 HOURS TOTAL ENGINE TIME ON BEARINGS, LOCKRING, BEARING SPACER AND SPRING SEATS.
1/30/63 FX-116 FE30582



25X1

25X1 [redacted]

FIGURE A-68

[redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1 2067189 S/N A02A020 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING BEARINGS AND SEALS. 18.84 HOURS TOTAL BENCH TIME. 69.55 HOURS TOTAL ENGINE TIME.

1-30-63 FX-116 FE 30580

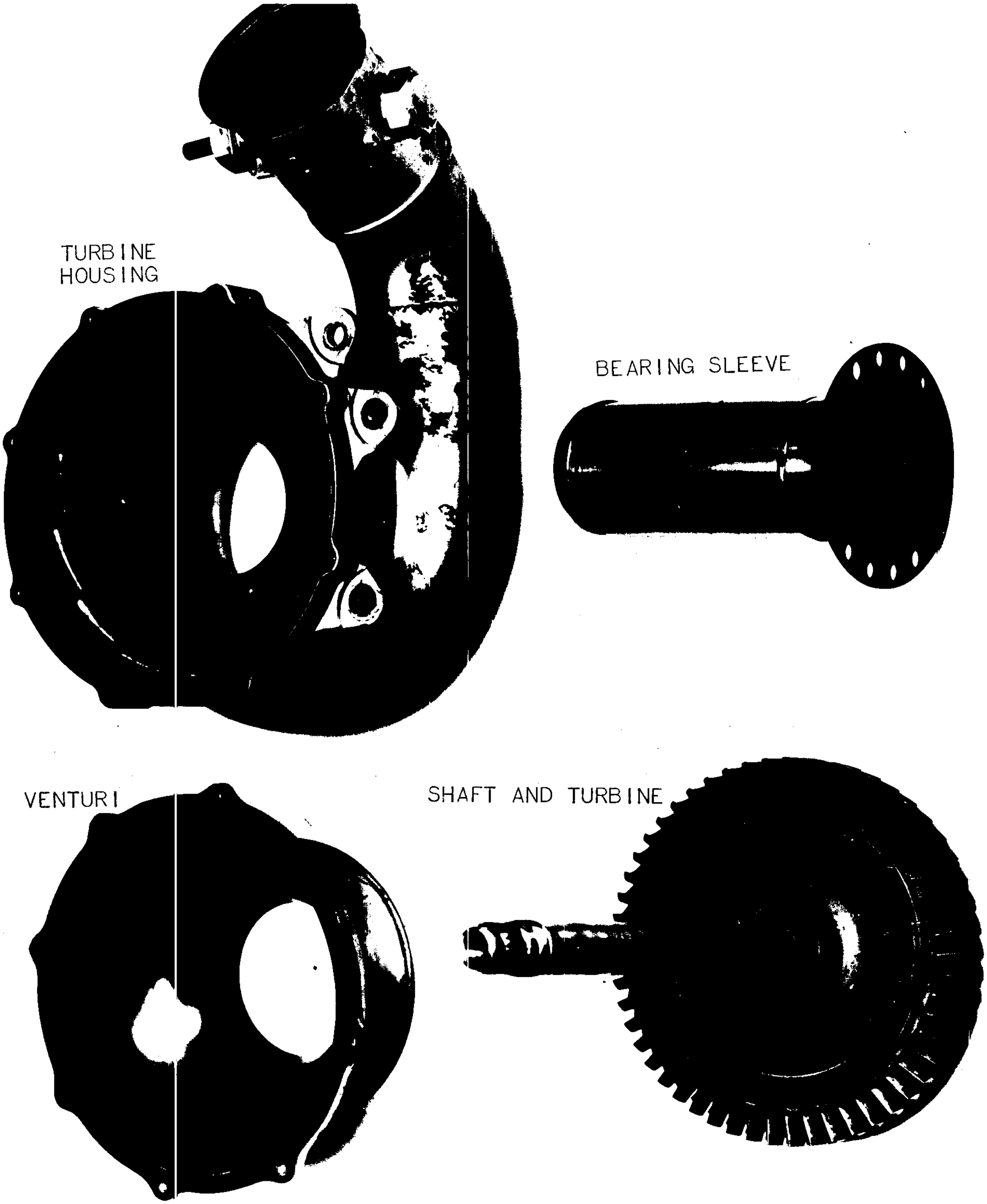
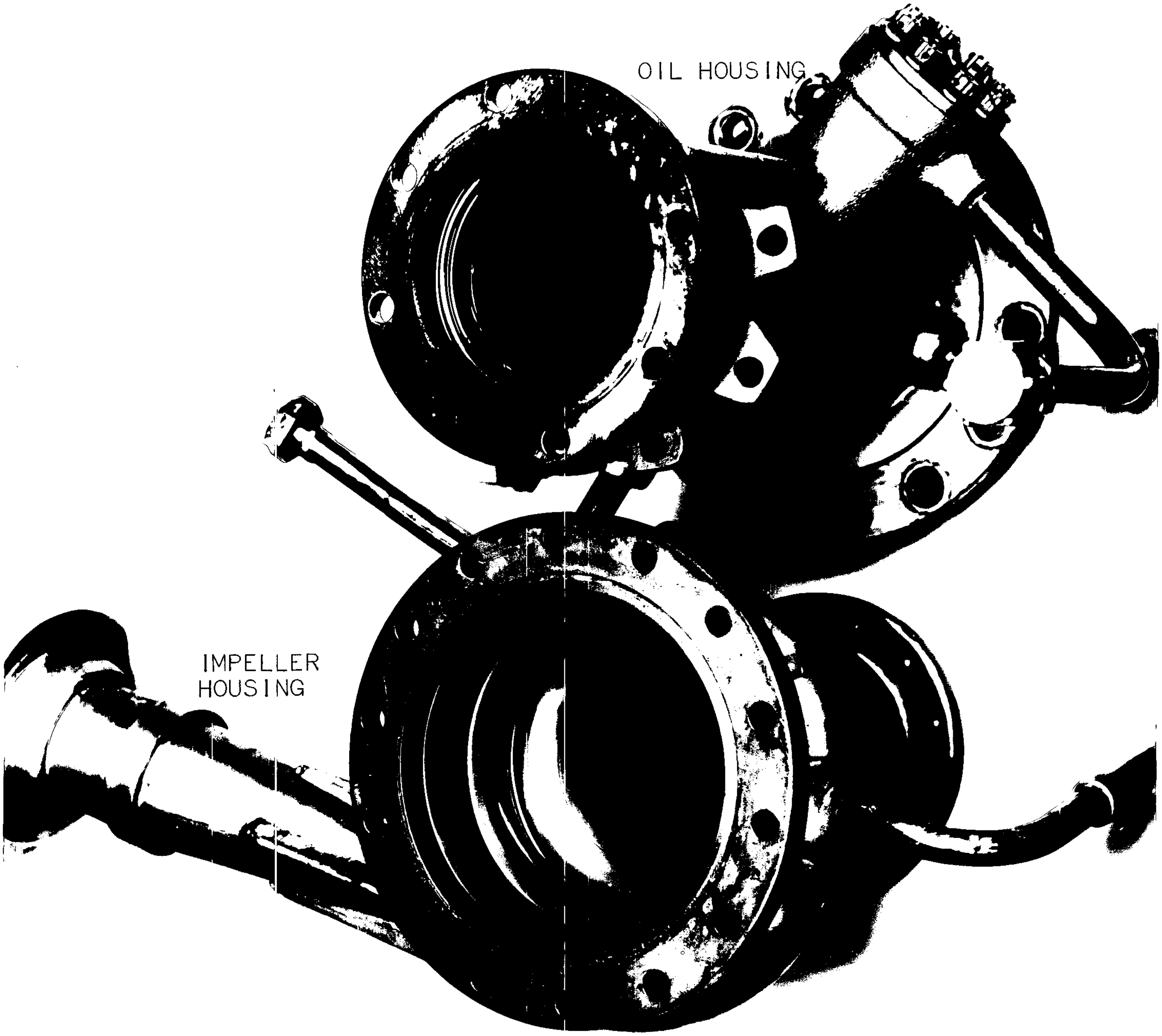


FIGURE A-71

[redacted]

[redacted] TP-C6580395 LI A/B TURBOPUMP [redacted] 25X1
2067189 S/N A02A004 AFTER FLIGHT SUITABILITY TEST ON
YJT11D-20A ENGINE FX-116 554.49 HOURS TOTAL
BENCH TIME, 198.19 HOURS TOTAL ENGINE TIME EXCEPT 3.24
HOURS TOTAL BENCH TIME AND 28.65 HOURS TOTAL ENGINE TIME
ON BEARING SLEEVE AND SHAFT.

1/30/63 FX-116 FE30583



25X1
25X1
[redacted]

FIGURE A -72

[redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A024A004 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING OIL HOUSING AND IMPELLER HOUSING. 554.49 HOURS TOTAL BENCH TIME, 198.19 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30584

25X1

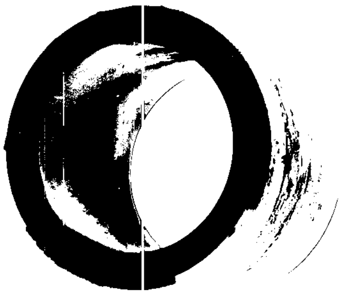
25X1

[redacted]

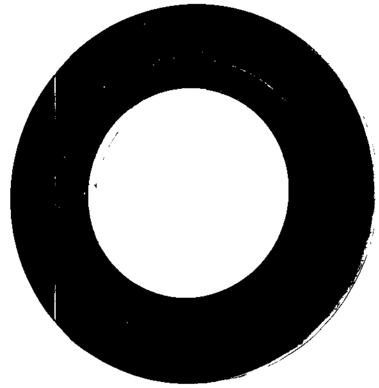
FIGURE A-73

[redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A02A004 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116, SHOWING OIL HOUSING AND FUEL SEAL. 554.49 HOURS TOTAL BENCH TIME, 198.17 HOURS TOTAL ENGINE TIME ON OIL HOUSING. 28.65 HOURS TOTAL ENGINE TIME ON FUEL SEAL.

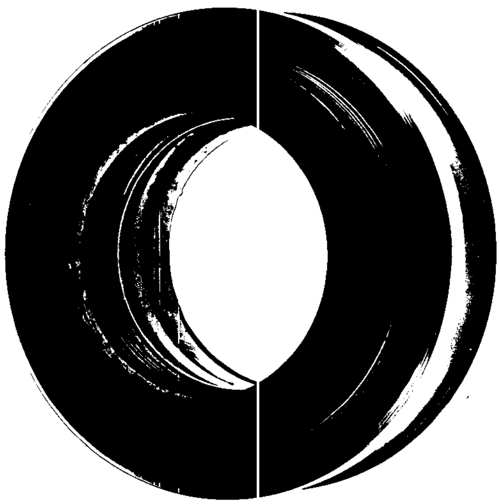
/30/63 FX-116 FE 30585



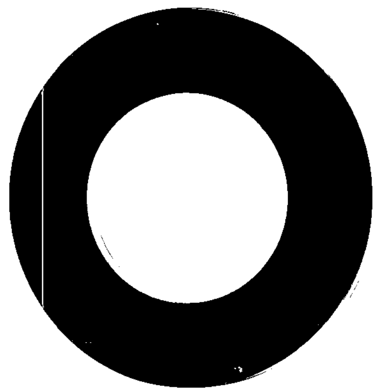
REAR OIL SEAL SPACER
580396-3



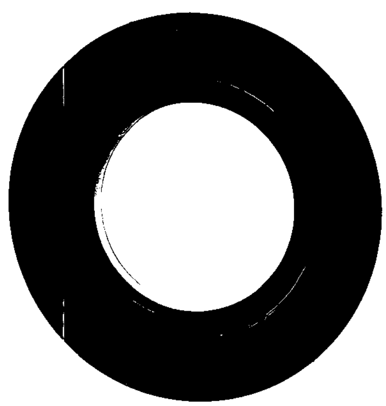
FRONT OIL SEAL
MATING RING
580397-2
BACK SIDE



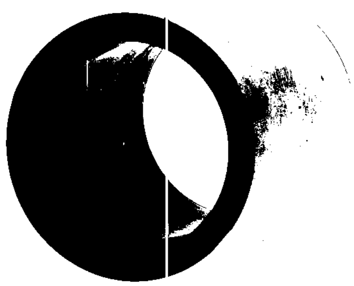
REAR OIL SEAL
580396-1



FRONT FUEL SEAL
MATING RING
580397-2
BACK SIDE



REAL OIL SEAL
MATING RING
580396-2
BACK SIDE

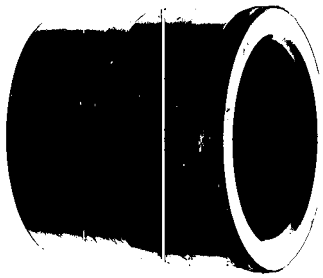


FRONT SEAL SPACER, 580397-3

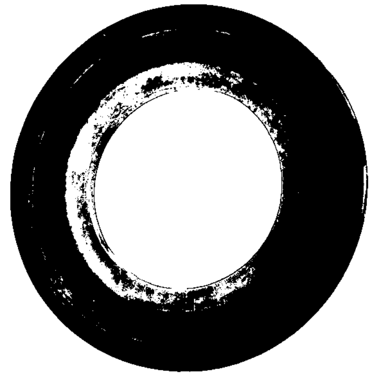
25X1 [redacted] FIGURE A-74

25X1 [redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A02A004 AFTER FLIGHT SUITABILITY TEST ON YJT11D-20A ENGINE FX-116 SHOWING SEAL. 3.24 HOURS TOTAL BENCH TIME, 28.65 HOURS TOTAL ENGINE TIME.

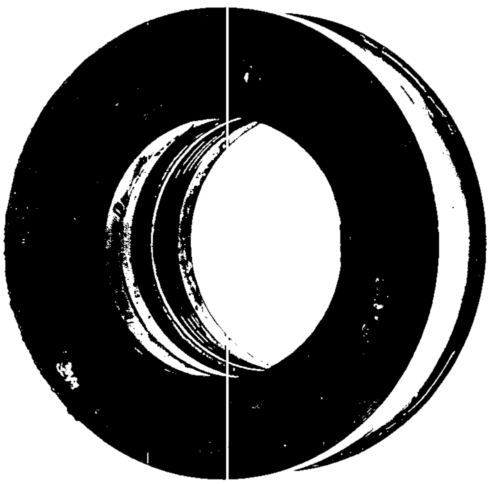
1/30/63 FX-116 FE 30586



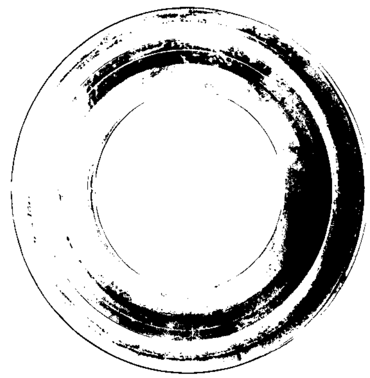
REAR OIL SEAL SPACER
580396-3



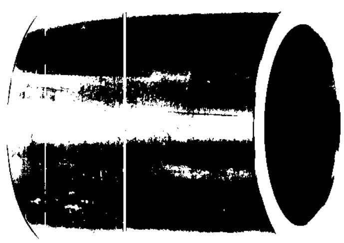
FRONT OIL
SEAL MATING
RING
580397-2
SEALING
SURFACE



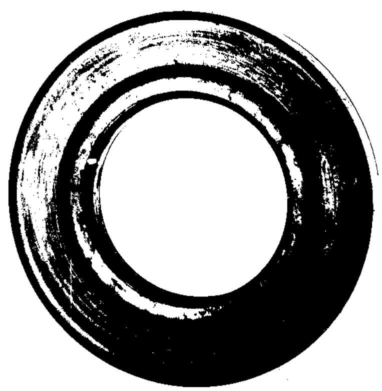
REAR OIL SEAL
580396-1
BACK SIDE



FRONT FUEL
SEAL MATING
RING
580397-2
SEALING
SURFACE



FRONT SEAL SPACER
580397-3



REAR OIL
SEAL MATING
RING
580396-2
SEALING
SURFACE

[redacted]

FIGURE A-75

[redacted] TP-C6 580395L1 A/B TURBO PUMP, [redacted] 25X1
2067189, S/N A02A004 AFTER FLIGHT SUITABILITY TEST ON
YJT11D-20A ENGINE FX-116 SHOWING SEALS. 3.24 HOURS
TOTAL BENCH TIME, 28.65 HOURS TOTAL ENGINE TIME.

1/30/63 FX-116 FE 30587